APPENDIX A

PRG DEVELOPMENT INFORMATION

TABLE 1-1
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Day Care Child
Receptor Age: Young Child (ages 1-6)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Surface Soil	SO	Arsenic	9.2E+01						Skin	2E+00	- -	1E-01	2E+00
			Chemical Total		- -	- -	- -	- -	- -		2E+00	- -	1E-01	2E+00
			Radionuclide Total											
		Exposure Point Total							- -					2E+00
	Exposure Medium Total								- -					2E+00
Medium Total									- -					2E+00
Receptor Total									- -					2E+00

- - = Not Evaluated
N/A = Not Applicable

Total Risk Across All Media: - -

Total Hazard Across All Media: 2E+00

Total Blood HI =	N/A
Total Cardiovascular HI =	N/A
Total Developmental HI =	N/A
Total General Toxicity HI =	N/A
Total GI System HI =	N/A
Total Immune System HI =	N/A
Total Kidney HI =	N/A
Total Liver HI =	N/A
Total Nervous System HI =	N/A
Total Skin HI =	2E+00
Total Respiratory HI =	N/A

TABLE 1-2
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Day Care Child
Receptor Age: Young Child (ages 1-6)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Subsurface Soil	SO	Arsenic	1.9E+03	1E-03	- -	1E-04	- -	1E-03	Skin	3E+01	- -	3E+00	4E+01
			Chemical Total		1E-03	- -	1E-04	- -	1E-03		3E+01	- -	3E+00	4E+01
			Radionuclide Total											
		Exposure Point Total							1E-03					4E+01
	Exposure Medium Total								1E-03					4E+01
Medium Total									1E-03					4E+01
Receptor Total									1E-03					4E+01

- - = Not Evaluated
N/A = Not Applicable

Total Risk Across All Media: 1E-03

Total Hazard Across All Media: 4E+01

Total Blood HI =	N/A
Total Cardiovascular HI =	N/A
Total Developmental HI =	N/A
Total General Toxicity HI =	N/A
Total GI System HI =	N/A
Total Immune System HI =	N/A
Total Kidney HI =	N/A
Total Liver HI =	N/A
Total Nervous System HI =	N/A
Total Skin HI =	4E+01
Total Respiratory HI =	N/A

TABLE 1-3
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg or ug/L)	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Subsurface Soil	SO	Arsenic	1.9E+03						Skin	6E+00	- -	6E-01	7E+00
			Chemical Total		- -	- -	- -	- -	- -		6E+00	- -	6E-01	7E+00
			Radionuclide Total											
		Exposure Point Total							- -					7E+00
	Exposure Medium Total								- -					7E+00
Medium Total									- -					7E+00
Groundwater	Shallow Groundwater	Study Area	Arsenic	3.4E+03						Skin	3E+00	- -	2E-01	3E+00
			Chemical Total		- -	- -	- -	- -	- -		3E+00	- -	2E-01	3E+00
			Radionuclide Total											
		Exposure Point Total							- -					3E+00
	Exposure Medium Total								- -					3E+00
Medium Total									- -					3E+00
Receptor Total									- -					1E+01

- - = Not Evaluated
N/A = Not Applicable

Total Risk Across All Media: - -

Total Hazard Across All Media: 1E+01

Total Blood HI =	N/A
Total Cardiovascular HI =	N/A
Total Developmental HI =	N/A
Total General Toxicity HI =	N/A
Total GI System HI =	N/A
Total Immune System HI =	N/A
Total Kidney HI =	N/A
Total Liver HI =	N/A
Total Nervous System HI =	N/A
Total Skin HI =	1E+01
Total Respiratory HI =	N/A

TABLE 1-4

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Station 13/TT-27	Benzo(a)pyrene	1.3E+00	2E-06	- -	1E-06	- -	3E-06					
			Arsenic	3.6E+03	5E-04	- -	2E-04	- -	7E-04	Skin	9E+00	- -	3E+00	1E+01
			Chemical Total		5E-04	- -	2E-04	- -	7E-04		9E+00	- -	3E+00	1E+01
			Radionuclide Total											
		Exposure Point Total							7E-04					1E+01
	Exposure Medium Total								7E-04					1E+01
Medium Total									7E-04					1E+01
Receptor Total									7E-04					1E+01

Total Risk Across All Media: 7E-04

Total Hazard Across All Media: 1E+01

Total Skin HI = 1E+01

TABLE 1-5

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Current
Receptor Population: Recreational User
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Station WH	Arsenic	1.9E+03						Skin	2E+00	- -	5E-01	2E+00
			Chemical Total		- -	- -	- -	- -	- -		2E+00	- -	5E-01	2E+00
			Radionuclide Total											
		Exposure Point Total							- -					2E+00
	Exposure Medium Total								- -					2E+00
Medium Total									- -					2E+00
Receptor Total									- -					2E+00

Total Risk Across All Media: - -

Total Hazard Across All Media: 2E+00

Total Skin HI = 2E+00

TABLE 1-6

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Station WH	Benzo(a)pyrene	1.0E+00	1E-06	- -	1E-06	- -	2E-06					
			Arsenic	1.9E+03	3E-04	- -	9E-05	- -	4E-04	Skin	5E+00	- -	2E+00	6E+00
			Chemical Total		3E-04	- -	1E-04	- -	4E-04		5E+00	- -	2E+00	6E+00
			Radionuclide Total											
		Exposure Point Total							4E-04					6E+00
	Exposure Medium Total								4E-04					6E+00
Medium Total									4E-04					6E+00
Receptor Total									4E-04					6E+00

Total Risk Across All Media: 4E-04

Total Hazard Across All Media: 6E+00

Total Skin HI = 6E+00

TABLE 1-7

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Station NT-3	Arsenic	5.0E+02						Skin	1E+00	- -	4E-01	2E+00
			Chemical Total		- -	- -	- -	- -	- -		1E+00	- -	4E-01	2E+00
			Radionuclide Total											
		Exposure Point Total							- -					2E+00
	Exposure Medium Total								- -					2E+00
Medium Total									- -					2E+00
Receptor Total									- -					2E+00

Total Risk Across All Media: - -

Total Hazard Across All Media: 2E+00

Total Skin HI = 2E+00

TABLE 1-8

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Current
Receptor Population: Recreational User
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Station CB-03	Arsenic	5.9E+02						Skin	2E+00	- -	6E-01	3E+00
			Chemical Total		- -	- -	- -	- -	- -		2E+00	- -	6E-01	3E+00
			Radionuclide Total											
		Exposure Point Total							- -					3E+00
	Exposure Medium Total								- -					3E+00
Medium Total									- -					3E+00
Receptor Total									- -					3E+00

Total Risk Across All Media: - -

Total Hazard Across All Media: 3E+00

Total Skin HI = 3E+00

TABLE 1-9

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Recreational User
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Station CB-03	Arsenic	5.9E+02						Skin	2E+00	- -	6E-01	3E+00
			Chemical Total		- -	- -	- -	- -	- -		2E+00	- -	6E-01	3E+00
			Radionuclide Total											
		Exposure Point Total							- -					3E+00
	Exposure Medium Total								- -					3E+00
Medium Total									- -					3E+00
Receptor Total									- -					3E+00

Total Risk Across All Media: - -

Total Hazard Across All Media: 3E+00

Total Skin HI = 3E+00

TABLE 1-10
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Dredger
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment Cores	SC02	Arsenic	1.6E+03						Skin	4E+00	- -	7E-01	4E+00
			Chemical Total		- -	- -	- -	- -	- -		4E+00	- -	7E-01	4E+00
			Radionuclide Total											
		Exposure Point Total							- -					4E+00
	Exposure Medium Total								- -					4E+00
Medium Total									- -					4E+00
Receptor Total									- -					4E+00

- - = Not Evaluated
N/A = Not Applicable

Total Risk Across All Media: - -

Total Hazard Across All Media: 4E+00

Total Blood HI =	N/A
Total Cardiovascular HI =	N/A
Total Developmental HI =	N/A
Total General Toxicity HI =	N/A
Total GI System HI =	N/A
Total Immune System HI =	N/A
Total Kidney HI =	N/A
Total Liver HI =	N/A
Total Nervous System HI =	N/A
Total Skin HI =	4E+00
Total Respiratory HI =	N/A

TABLE 1-11

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Dredger
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment Cores	SC05	Arsenic	9.0E+02						Skin	2E+00	- -	4E-01	2E+00
			Chemical Total		- -	- -	- -	- -	- -		2E+00	- -	4E-01	2E+00
			Radionuclide Total											
		Exposure Point Total							- -					2E+00
	Exposure Medium Total								- -					2E+00
Medium Total									- -					2E+00
Receptor Total									- -					2E+00

Total Risk Across All Media: - -

Total Hazard Across All Media: 2E+00

Total Skin HI = 2E+00

TABLE 1-12

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Dredger
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment Cores	SC06	Arsenic	1.7E+03						Skin	4E+00	- -	7E-01	4E+00
			Chemical Total		- -	- -	- -	- -	- -		4E+00	- -	7E-01	4E+00
			Radionuclide Total											
		Exposure Point Total							- -					4E+00
	Exposure Medium Total								- -					4E+00
Medium Total									- -					4E+00
Receptor Total									- -					4E+00

Total Risk Across All Media: - -

Total Hazard Across All Media: 4E+00

Total Skin HI = 4E+00

TABLE 1-13

RISK SUMMARY

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Dredger
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (mg/kg)	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment Cores	SC08	Arsenic	1.3E+03						Skin	3E+00	- -	5E-01	3E+00
			Chemical Total		- -	- -	- -	- -	- -		3E+00	- -	5E-01	3E+00
			Radionuclide Total											
		Exposure Point Total							- -					3E+00
	Exposure Medium Total								- -					3E+00
Medium Total									- -					3E+00
Receptor Total									- -					3E+00

Total Risk Across All Media: - -

Total Hazard Across All Media: 3E+00

Total Skin HI = 3E+00

TABLE 1-14
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Industrial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (ug/L)	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Study Area												
			Benzene	2.4E+03	2E-05	- -	4E-05	- -	6E-05					
			Trichloroethene	9.5E+00	7E-07	- -	1E-06	- -	2E-06					
			Arsenic	1.1E+03	3E-04	- -	2E-05	- -	3E-04	Skin	2E+00	- -	1E-01	2E+00
			Chemical Total		3E-04	- -	6E-05	- -	4E-04		2E+00	- -	1E-01	2E+00
			Radionuclide Total											
		Exposure Point Total							4E-04					2E+00
	Exposure Medium Total								4E-04					2E+00
	Indoor Air	Study Area												
			1,2-Dichloroethane	2.1E+00	- -	1E-05	- -	- -	1E-05					
			Benzene	2.4E+03	- -	4E-03	- -	- -	4E-03	Immune System	- -	5E+01	- -	5E+01
			Trichloroethene	9.5E+00	- -	2E-04	- -	- -	2E-04					
			Naphthalene	2.8E+01						Respiratory	- -	6E+00	- -	6E+00
			Chemical Total		- -	4E-03	- -	- -	4E-03		- -	5E+01	- -	5E+01
			Radionuclide Total											
		Exposure Point Total							4E-03					5E+01
	Exposure Medium Total								4E-03					5E+01
Medium Total									5E-03					6E+01
Receptor Total									5E-03					6E+01

- - = Not Evaluated
N/A = Not Applicable

Total Risk Across All Media: 5E-03

Total Hazard Across All Media: 6E+01

Using the NCEA low-end slope factor/unit risk for TCE, the risk for this receptor would change to: 4E-03
Using the CalEPA slope factor/unit risk for TCE, the risk for this receptor would change to: 4E-03
Using the MADEP slope factor/unit risk for TCE, the risk for this receptor would change to: 4E-03

Total Blood HI =	N/A
Total Cardiovascular HI =	N/A
Total Developmental HI =	N/A
Total General Toxicity HI =	N/A
Total GI System HI =	N/A
Total Immune System HI =	5E+01
Total Kidney HI =	N/A
Total Liver HI =	N/A
Total Nervous System HI =	N/A
Total Skin HI =	2E+00
Total Respiratory HI =	6E+00

TABLE 1-15
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Receptor Population: Car Wash Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	EPC (ug/L)	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
					Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Indoor Air	Study Area												
			1,2-Dichloroethane	2.1E+00	- -	1E-05	- -	- -	1E-05					
			Benzene	2.4E+03	- -	6E-03	- -	- -	6E-03	Immune System	- -	7E+01	- -	7E+01
			Trichloroethene	9.5E+00	- -	3E-04	- -	- -	3E-04					
			Naphthalene	2.8E+01						Respiratory	- -	5E+00	- -	5E+00
			Chemical Total		- -	6E-03	- -	- -	6E-03		- -	8E+01	- -	8E+01
			Radionuclide Total											
		Exposure Point Total							6E-03					8E+01
	Exposure Medium Total								6E-03					8E+01
Medium Total									6E-03					8E+01
Receptor Total									6E-03					8E+01

- - = Not Evaluated
N/A = Not Applicable

Total Risk Across All Media: 6E-03

Total Hazard Across All Media: 8E+01

Using the NCEA low-end unit risk for TCE, the risk for this receptor would change to: 6E-03
Using the CalEPA unit risk for TCE, the risk for this receptor would change to: 6E-03
Using the MADEP unit risk for TCE, the risk for this receptor would change to: 6E-03

Total Blood HI =	N/A
Total Cardiovascular HI =	N/A
Total Developmental HI =	N/A
Total General Toxicity HI =	N/A
Total GI System HI =	N/A
Total Immune System HI =	7E+01
Total Kidney HI =	N/A
Total Liver HI =	N/A
Total Nervous System HI =	N/A
Total Skin HI =	N/A
Total Respiratory HI =	5E+00

TABLE 2-1

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Surface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal	Day Care Child	Young Child (ages 1-6)	SO	IR	Ingestion Rate of Soil	200	mg/day	USEPA, 1997a	Preliminary Remediation Goal (PRG) cancer = $\frac{TR \times AT\text{-}C}{SF \times EF \times FI \times CF \times (IF + DF)}$
				FI	Fraction Ingested	1	unitless	Prof. Judgement	
				EF	Exposure Frequency	150	days/year	USEPA, 1994b	where ingestion factor (IF) = $\frac{ED \times IR}{BW}$
				ED	Exposure Duration	6	years	USEPA, 1994b	
				BW	Body Weight	15	kg	USEPA, 1997a	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	and dermal factor (DF) = $\frac{ED \times SA \times AF \times DAF}{BW}$
				AT-N	Averaging Time (Non-Cancer)	2,190	days	USEPA, 1989	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				SA	Skin Surface Area Available for Contact	2,800	cm^2	USEPA, 2004a	Preliminary Remediation Goal (PRG) non-cancer = $\frac{THI \times RfD \times BW \times AT\text{-}N}{ED \times EF \times CF \times [IR + (SA \times AF \times DAF)]}$
				AF	Skin Adherence Factor	0.2	mg/cm^2-day	USEPA, 2004a	
				DAF	Arsenic Dermal Absorption Factor	0.03	- -	- -	
				RfD	Arsenic Oral Reference Dose	3E-04	mg/kg-day	- -	
				THI	Target Hazard Index	1	- -	- -	
				SF	Arsenic Oral Slope Factor	1.5E+00	$(mg/kg\text{-}day)^{-1}$	- -	
				TR	Target ILCR	10^{-6} to 10^{-4}	- -	- -	

TABLE 2-2

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Subsurface Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal	Day Care Child	Young Child	SO						Preliminary Remediation Goal (PRG) cancer =
		(ages 1-6)		IR	Ingestion Rate of Soil	200	mg/day	USEPA, 1997a	$\frac{TR \times AT\text{-}C}{SF \times EF \times FI \times CF \times (IF + DF)}$
				FI	Fraction Ingested	1	unitless	Prof. Judgement	
				EF	Exposure Frequency	150	days/year	USEPA, 1994b	where ingestion factor (IF) =
				ED	Exposure Duration	6	years	USEPA, 1994b	$\frac{ED \times IR}{BW}$
				BW	Body Weight	15	kg	USEPA, 1997a	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	and dermal factor (DF) =
				AT-N	Averaging Time (Non-Cancer)	2,190	days	USEPA, 1989	$\frac{ED \times SA \times AF \times DAF}{BW}$
				CF	Conversion Factor	0.000001	kg/mg	- -	
				SA	Skin Surface Area Available for Contact	2,800	cm^2	USEPA, 2004a	Preliminary Remediation Goal (PRG) non-cancer =
				AF	Skin Adherence Factor	0.2	mg/cm^2-day	USEPA, 2004a	$\frac{THI \times RfD \times BW \times AT\text{-}N}{ED \times EF \times CF \times [IR + (SA \times AF \times DAF)]}$
				DAF	Arsenic Dermal Absorption Factor	0.03	- -	USEPA, 2004a	
				RfD	Arsenic Oral Reference Dose	3E-04	mg/kg-day	- -	
				THI	Target Hazard Index	1	- -	- -	
				SF	Arsenic Oral Slope Factor	1.5E+00	$(mg/kg\text{-}day)^{-1}$	- -	
				TR	Target ILCR	10^{-6} to 10^{-4}	- -	- -	
Ingestion/Dermal	Construction Worker	Adult	SO						Preliminary Remediation Goal (PRG) cancer =
				IR	Ingestion Rate of Soil	200	mg/day	USEPA, 1997a	$\frac{TR \times AT\text{-}C}{SF \times EF \times FI \times CF \times (IF + DF)}$
				FI	Fraction Ingested	1	unitless	Prof. Judgement	
				EF	Exposure Frequency	125	days/year	Prof. Judgement	where ingestion factor (IF) =
				ED	Exposure Duration	1	years	Prof. Judgement	$\frac{ED \times IR}{BW}$
				BW	Body Weight	70	kg	USEPA, 1997a	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	and dermal factor (DF) =
				AT-N	Averaging Time (Non-Cancer)	365	days	USEPA, 1989	$\frac{ED \times SA \times AF \times DAF}{BW}$
				CF	Conversion Factor	0.000001	kg/mg	- -	
				SA	Skin Surface Area Available for Contact	3,300	cm^2	USEPA, 2004a	Preliminary Remediation Goal (PRG) non-cancer =
				AF	Skin Adherence Factor	0.2	mg/cm^2-day	USEPA, 2004a	$\frac{THI \times RfD \times BW \times AT\text{-}N}{ED \times EF \times CF \times [IR + (SA \times AF \times DAF)]}$
				DAF	Arsenic Dermal Absorption Factor	0.03	- -	- -	
				RfD	Arsenic Oral Reference Dose	3E-04	mg/kg-day	- -	
				THI	Target Hazard Index	1	- -	- -	
				SF	Arsenic Oral Slope Factor	1.5E+00	$(mg/kg\text{-}day)^{-1}$	- -	
				TR	Target ILCR	10^{-6} to 10^{-4}	- -	- -	

TABLE 2-3

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal	Recreational User	Adult/Young Child	Stations WH, NT-3, and 13/TT-27						Preliminary Remediation Goal (PRG) cancer =
				IR_A	Ingestion Rate of Sediment - adult	100	mg/day	USEPA, 1994b	$\frac{TR \times BW_A \times AT\text{-}C}{SF_O \times IR_A \times FI \times EF \times ED_A \times CF} + \frac{TR \times BW_C \times AT\text{-}C}{SF_O \times IR_C \times FI \times EF \times ED_C \times CF} +$
				FI	Fraction Ingested	0.5	unitless	Prof. Judgement	
				EF	Exposure Frequency	78	days/year	assumption	
				ED_A	Exposure Duration - adult	24	years	USEPA, 1994b	$\frac{TR \times BW_A \times AT\text{-}C}{SF_D \times SA_A \times AF_A \times EF \times ED_A \times DAF} + \frac{TR \times BW_C \times AT\text{-}C}{SF_D \times SA_C \times AF_C \times EF \times ED_C \times DAF}$
				BW_A	Body Weight - adult	70	kg	USEPA, 1994b	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	days	USEPA, 1989	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				SA_A	Skin Surface Area for contact - adult	5,700	cm^2	USEPA, 2004d	Preliminary Remediation Goal (PRG) non-cancer =
				AF_A	Skin Adherence Factor - adult	0.07	mg/cm^2-day	USEPA, 2004d	$\frac{THI \times RfD_O \times BW_C \times AT\text{-}N}{IR_C \times FI \times EF \times ED_C \times CF} + \frac{THI \times RfD_D \times BW_C \times AT\text{-}N}{SA_C \times AF_C \times EF \times ED_C \times DAF}$
				DAF	Arsenic Dermal Absorption Factor	0.03	- -	- -	
				RfD_O	Arsenic Oral Reference Dose	5.9E-04	mg/kg-day	- -	
				RfD_D	Arsenic Dermal Reference Dose	3.0E-04	mg/kg-day	- -	
				THI	Target Hazard Index	1	- -	- -	
				SF_O	Arsenic Oral Slope Factor	7.7E-01	$(mg/kg\text{-}day)^{-1}$	- -	
				SF_D	Arsenic Dermal Slope Factor	1.5E+00	$(mg/kg\text{-}day)^{-1}$	- -	
				TR	Target ILCR	10^{-6} to 10^{-4}	- -	- -	
				IR_C	Ingestion Rate of Sediment - child	200	mg/day	USEPA, 1994b	
				ED_C	Exposure Duration - child	6	years	USEPA, 1994b	
				BW_C	Body Weight - child	15	kg	USEPA, 1994b	
				SA_C	Skin Surface Area Available - child	2,800	cm^2	USEPA, 2004d	
				AF_C	Skin Adherence Factor - child	0.2	mg/cm^2-day	USEPA, 2004d	

TABLE 2-3

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal (cont.)	Recreational User (cont.)	Adult/Young Child (cont.)	Station CB-03						Preliminary Remediation Goal (PRG) cancer =
				IR_A	Ingestion Rate of Sediment - adult	100	mg/day	USEPA, 1994b	$\frac{TR \times BW_A \times AT\text{-}C}{SF_O \times IR_A \times FI \times EF \times ED_A \times CF} + \frac{TR \times BW_C \times AT\text{-}C}{SF_O \times IR_C \times FI \times EF \times ED_C \times CF} +$
				FI	Fraction Ingested	0.5	unitless	Prof. Judgement	
				EF	Exposure Frequency	104	days/year	assumption	
				ED_A	Exposure Duration - adult	24	years	USEPA, 1994b	$\frac{TR \times BW_A \times AT\text{-}C}{SF_D \times SA_A \times AF_A \times EF \times ED_A \times DAF} + \frac{TR \times BW_C \times AT\text{-}C}{SF_D \times SA_C \times AF_C \times EF \times ED_C \times DAF}$
				BW_A	Body Weight - adult	70	kg	USEPA, 1994b	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	days	USEPA, 1989	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				SA_A	Skin Surface Area for contact - adult	5,700	cm^2	USEPA, 2004d	Preliminary Remediation Goal (PRG) non-cancer =
				AF_A	Skin Adherence Factor - adult	0.07	mg/cm^2-day	USEPA, 2004d	$\frac{THI \times RfD_O \times BW_C \times AT\text{-}N}{IR_C \times FI \times EF \times ED_C \times CF} + \frac{THI \times RfD_D \times BW_C \times AT\text{-}N}{SA_C \times AF_C \times EF \times ED_C \times DAF}$
				DAF	Dermal Absorption Factor	0.03	- -	- -	
				RfD_O	Arsenic Oral Reference Dose	5.9E-04	mg/kg-day	- -	
				RfD_D	Arsenic Dermal Reference Dose	3.0E-04	mg/kg-day		
				THI	Target Hazard Index	1	- -	- -	
				SF_O	Arsenic Oral Slope Factor	7.7E-01	$(mg/kg\text{-}day)^{-1}$	- -	
				SF_D	Arsenic Dermal Slope Factor	1.5E+00	$(mg/kg\text{-}day)^{-1}$		
				TR	Target ILCR	10^{-6} to 10^{-4}	- -	- -	
				IR_C	Ingestion Rate of Sediment - child	200	mg/day	USEPA, 1994b	
				ED_C	Exposure Duration - child	6	years	USEPA, 1994b	
				BW_C	Body Weight - child	15	kg	USEPA, 1994b	
				SA_C	Skin Surface Area Available - child	2,800	cm^2	USEPA, 2004d	
				AF_C	Skin Adherence Factor - child	0.2	mg/cm^2-day	USEPA, 2004d	

TABLE 2-4

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment Cores

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal	Dredger	Adult	Sediment Cores						Preliminary Remediation Goal (PRG) cancer =
				IR	Ingestion Rate of Sediment	200	mg/day	USEPA, 1997a	$\frac{TR \times BW \times AT\text{-}C}{SF_O \times IR \times FI \times EF \times ED \times CF} + \frac{TR \times BW \times AT\text{-}C}{SF_D \times SA \times AF \times EF \times ED \times DAF}$
				FI	Fraction Ingested	1	unitless	Prof. Judgement	
				EF	Exposure Frequency	167	days/year	Prof. Judgement	
				ED	Exposure Duration	2	years	Prof. Judgement	Preliminary Remediation Goal (PRG) non-cancer =
				BW	Body Weight	70	kg	USEPA, 1997a	$\frac{THI \times RfD_O \times BW \times AT\text{-}N}{IR \times FI \times EF \times ED \times CF} + \frac{THI \times RfD_D \times BW \times AT\text{-}N}{SA \times AF \times EF \times ED \times DAF}$
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	730	days	USEPA, 1989	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				SA	Skin Surface Area Available for Contact	3,300	cm^2	USEPA, 2004a	
				AF	Skin Adherence Factor	0.2	mg/cm^2-day	USEPA, 2004a	
				DAF	Dermal Absorption Factor	0.03	- -	- -	
				RfD_O	Arsenic Oral Reference Dose	5.9E-04	mg/kg-day	- -	
				RfD_D	Arsenic Dermal Reference Dose	3.0E-04	mg/kg-day		
				THI	Target Hazard Index	1	- -	- -	
				SF_O	Arsenic Oral Slope Factor	7.7E-01	$(mg/kg\text{-}day)^{-1}$	- -	
				SF_D	Arsenic Dermal Slope Factor	1.5E+00	$(mg/kg\text{-}day)^{-1}$		
				TR	Target ILCR	10^{-6} to 10^{-4}	- -	- -	

TABLE 2-5

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal/ Inhalation of Volatiles	Industrial Worker	Adult	Study Area						**Inorganics:**
				IR	Ingestion Rate of Water	0.05	liters/day	Prof. Judgement	Preliminary Remediation Goal (PRG) cancer =
				EF	Exposure Frequency	250	days/year	USEPA, 1997a	$\frac{TR \times BW \times AT\text{-}C}{SF \times IR \times EF \times ED \times CF1} + \frac{TR \times BW \times AT\text{-}C}{SF \times SA \times PC \times ET \times EV \times EF \times ED \times CF1 \times CF2}$
				ED	Exposure Duration	25	years	USEPA, 1997a	
				BW	Body Weight	70	kg	USEPA, 1997a	
				AT-C	Averaging Time (Cancer)	25550	days	USEPA, 1989	Preliminary Remediation Goal (PRG) non-cancer =
				AT-N	Averaging Time (Non-Cancer)	9125	days	USEPA, 1989	$\frac{THI \times RfD \times BW \times AT\text{-}N}{IR \times EF \times ED \times CF1} + \frac{THI \times RfD \times BW \times AT\text{-}N}{SA \times PC \times ET \times EV \times EF \times ED \times CF1 \times CF2}$
				CF1	Conversion Factor 1	0.001	mg/ug	- -	
				TR	Target ILCR	10^{-6} to 10^{-4}	- -	- -	**Organics:**
				DA	Dose Absorbed per Unit Area per Event	see Table 5-1	mg/cm^2-event	USEPA, 2004a	Preliminary Remediation Goal (PRG) cancer =
				SA	Skin Surface Area Available for Contact	3300	cm^2	USEPA, 2004a	$\frac{TR \times BW \times AT\text{-}C}{SF \times IR \times EF \times ED \times CF1} + \frac{TR \times BW \times AT\text{-}C}{SF \times DA \times SA \times EV \times EF \times ED} +$
				PC	Arsenic Permeability Constant	1E-03	cm/hr	USEPA, 2004a	
				ET	Event Time	1	hrs/event	Prof. Judgement	$\frac{TR \times AT\text{-}C \times CF3}{UR \times EXT \times EF \times ED}$
				EV	Event Frequency	1	events/day	Prof. Judgement	
				SF	Oral Slope Factor	see Table 4-1	$(mg/kg\text{-}day)^{-1}$	- -	
				RfD	Oral Reference Dose	see Table 3-1	mg/kg-day	- -	Preliminary Remediation Goal (PRG) non-cancer =
				THI	Target Hazard Index	1	- -	- -	$\frac{THI \times RfD \times BW \times AT\text{-}N}{IR \times EF \times ED \times CF1} + \frac{THI \times RfD \times BW \times AT\text{-}N}{DA \times SA \times EV \times EF \times ED} +$
				UR	Inhalation Unit Risk	see Table 4-2	$(ug/m^3)^{-1}$	- -	
				CF2	Conversion Factor 2	0.001	L/cm^3	- -	$\frac{THI \times RfC \times AT\text{-}N \times CF3}{EXT \times EF \times ED}$
				EXT	Exposure Time	8	hrs/day	USEPA, 1997a	
				RfC	Inhalation Reference Concentration	see Table 3-2	ug/m^3	- -	
				CF3	Conversion Factor 3	24	hrs/day	- -	
Inhalation of volatiles	Car Wash Worker	Adult	Study Area						Preliminary Remediation Goal (PRG) cancer =
				EXT	Exposure Time	8	hrs/day	USEPA, 1997a	$\frac{TR \times AT\text{-}C \times CF3}{UR \times EXT \times EF \times ED}$
				EF	Exposure Frequency	250	days/year	USEPA, 1997a	
				ED	Exposure Duration	25	years	USEPA, 1997a	Preliminary Remediation Goal (PRG) non-cancer =
				CF3	Conversion Factor 3	24	hrs/day	- -	$\frac{THI \times RfC \times AT\text{-}N \times CF3}{EXT \times EF \times ED}$
				TR	Target ILCR	10^{-6} to 10^{-4}	- -	- -	
				UR	Inhalation Unit Risk	see Table 4-2	$(ug/m^3)^{-1}$	- -	
				THI	Target Hazard Index	1	- -	- -	
				RfC	Inhalation Reference Concentration	see Table 3-2	ug/m^3	- -	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	USEPA, 1989	

TABLE 2-6

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

MSGRP FEASIBILITY STUDY

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Shallow Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal	Construction Worker	Adult	Study Area						Preliminary Remediation Goal (PRG) cancer =
				IR	Ingestion Rate of Water	0.05	liters/day	Prof. Judgement	$\frac{TR \times BW \times AT\text{-}C}{SF \times IR \times EF \times ED \times CF1} + \frac{TR \times BW \times AT\text{-}C}{SF \times SA \times PC \times ET \times EV \times EF \times ED \times CF1 \times CF2}$
				EF	Exposure Frequency	125	days/year	Prof. Judgement	
				ED	Exposure Duration	1	years	Prof. Judgement	
				BW	Body Weight	70	kg	USEPA, 1997a	Preliminary Remediation Goal (PRG) non-cancer =
				AT-C	Averaging Time (Cancer)	25550	days	USEPA, 1989	$\frac{THI \times RfD \times BW \times AT\text{-}N}{IR \times EF \times ED \times CF1} + \frac{THI \times RfD \times BW \times AT\text{-}N}{SA \times PC \times ET \times EV \times EF \times ED \times CF1 \times CF2}$
				AT-N	Averaging Time (Non-Cancer)	365	days	USEPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/ug	- -	
				SA	Skin Surface Area Available for Contact	3300	cm^2	USEPA, 2004a	
				PC	Arsenic Permeability Constant	1E-03	cm/hr	USEPA, 2004a	
				ET	Event Time	1	hrs/event	Prof. Judgement	
				EV	Event Frequency	1	events/day	Prof. Judgement	
				RfD	Arsenic Oral Reference Dose	3.0E-04	mg/kg-day	- -	
				THI	Target Hazard Index	1	- -	- -	
				SF	Arsenic Oral Slope Factor	1.5E+00	$(mg/kg\text{-}day)^{-1}$	- -	
				CF2	Conversion Factor 2	0.001	L/cm^3	- -	
				TR	Target ILCR	10^{-6} to 10^{-4}	- -	- -	

TABLE 3-1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

MSGRP FEASIBILITY STUDY

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal	Absorbed RfD for Dermal		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units	(1)	Value (2)	Units			Source(s)	Date(s) (MM/DD/YYYY)
Benzene	Chronic	4E-03	mg/kg-day	(3)	4E-03	mg/kg-day	Immune System	300	IRIS	01/05/05
Trichloroethene	Chronic	3E-04	mg/kg-day	(3)	3E-04	mg/kg-day	Liver	3000	NCEA	01/05/05
Benzo(a)pyrene	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic [5]	Chronic/Subchronic	3E-04	mg/kg-day	(3)	3E-04	mg/kg-day	Skin	3	IRIS	01/05/05

(1) Oral absorption efficiencies from RAGS, Part E (USEPA, 2004).

(2) Calculated as: (oral RfD) x (oral to dermal adjustment factor).

(3) Oral absorption efficiency exceeds 50%. No adjustment of the oral reference dose is necessary.

(4) Permeability constants (Kp) used for water absorption calculations: 1E-03 cm/hr for arsenic (USEPA, 2004); for organics, see Table 5-1.

(5) Used for all media and exposures except oral exposures to sediment (see Table 3-3).

IRIS = Integrated Risk Information System

NCEA = National Center for Environmental Assessment

N/A = Not Applicable

TABLE 3-2

NON-CANCER TOXICITY DATA -- INHALATION

MSGRP FEASIBILITY STUDY

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
1,2-Dichloroethane	Chronic	5.00E+00	ug/m^3	N/A	N/A	Liver/Kidney/GI System	3000	NCEA	1/5/2005
Benzene	Chronic	3.00E+01	ug/m^3	N/A	N/A	Immune System	300	IRIS	1/5/2005
Trichloroethene	Chronic	4.00E+01	ug/m^3	N/A	N/A	Liver/CNS	3000	NCEA	1/5/2005
Naphthalene	Chronic	3.00E+00	ug/m^3	N/A	N/A	Respiratory	3000	IRIS	1/5/2005

IRIS = Integrated Risk Information System

NCEA = National Center for Environmental Assessment

N/A = Not Applicable

TABLE 3-3

NON-CANCER TOXICITY DATA -- SPECIAL CASE CHEMICALS

MSGRP FEASIBILITY STUDY

Chemical of Potential Concern	Chronic/ Subchronic	Parameter			Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	Parameter:Target Organ(s)	
		Name	Value	Units			Source(s)	Date(s)
Arsenic	Chronic	Sediment Oral RfD adjusted for site-specific relative bioavailability	5.9E-04	mg/kg-day	skin	3	IRIS	01/05/05

TABLE 4-1

CANCER TOXICITY DATA -- ORAL/DERMAL

MSGRP FEASIBILITY STUDY

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal	Absorbed Cancer Slope Factor for Dermal		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units	(1)	Value (2)	Units		Source(s)	Date(s) (MM/DD/YYYY)
Benzene	5.50E-02	$(mg/kg\text{-}day)^{-1}$	(1)	5.50E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	01/05/05
Trichloroethene	4.0E-01	$(mg/kg\text{-}day)^{-1}$	(1)	4.0E-01	$(mg/kg\text{-}day)^{-1}$	C-B2	NCEA	01/05/05
Benzo(a)pyrene	7.3E+00	$(mg/kg\text{-}day)^{-1}$	(1)	7.3E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	01/05/05
Arsenic (3)	1.5E+00	$(mg/kg\text{-}day)^{-1}$	(1)	1.5E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	01/05/05

IRIS = Integrated Risk Information System

NCEA = National Center for Environmental Assessment

N/A = Not Applicable

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen (by the oral route)

E - Evidence of noncarcinogenicity

(1) Oral absorption efficiency exceeds 50%. Therefore, no adjustment of the oral slope factor is necessary.

(2) Calculated as: (oral slope factor) / (oral to dermal adjustment factor)

(3) Used for all media and exposures except oral exposures to sediment (see Table 4-3).

TABLE 4-2

CANCER TOXICITY DATA -- INHALATION

MSGRP FEASIBILITY STUDY

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
1,2-Dichloroethane	2.60E-05	$(ug/m^3)^{-1}$	N/A	N/A	B2	IRIS	01/05/05
Benzene	7.80E-06	$(ug/m^3)^{-1}$	N/A	N/A	A	IRIS	01/05/05
Trichloroethene	1.10E-04	$(ug/m^3)^{-1}$	N/A	N/A	C-B2	NCEA	01/05/05
Naphthalene	N/A	N/A	N/A	N/A	C	IRIS	01/05/05

IRIS = Integrated Risk Information System

NCEA = National Center for Environmental Assessment

CalEPA = California Environmental Protection Agency

N/A = Not Applicable

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen (by the oral route)

E - Evidence of noncarcinogenicity

TABLE 4-3

CANCER TOXICITY DATA -- SPECIAL CASE CHEMICALS

MSGRP FEASIBILITY STUDY

Chemical of Potential Concern	Parameter			Parameter:Target Organ(s)	
	Name	Value	Units	Source(s)	Date(s)
Arsenic	Sediment oral cancer slope factor adjusted for site-specific relative bioavailability	7.7E-01	(mg/kg-day) $^{-1}$	IRIS	01/05/05

TABLE 5-1. DERMALLY ABSORBED DOSE CALCULATIONS - GROUNDWATER
(Variable Definitions follow Table)

Exposure Point	Timeframe	Receptor	Cancer/ Non-cancer	RME/ CT	A cm^2	t_event hr/event	EV event/day	EF days/yr	ED years	BW kg	AT days	Isc cm	IR cm^3/day	ABSGI	Chemical	CAS No.	MWT	logKow	Kp 95% LCI	Kp (cm/hr) predicted	Kp (cm/hr) measured	Kp 95% UCI
Study Area	Future	Indust. Worker	Non-cancer	RME																		
					3300	1	1	250	25	70	9125	1.0E-03	2000	1	1,2-Dichloroethane	107062	99.0	1.48	1.7E-04	4.2E-03	NA	1.0E-01
					3300	1	1	250	25	70	9125	1.0E-03	2000	1	Benzene	71432	78.1	2.13	5.9E-04	1.5E-02	NA	3.7E-01
					3300	1	1	250	25	70	9125	1.0E-03	2000	1	Trichloroethene	79016	131.4	2.42	NA	1.2E-02	1.6E-02	NA
					3300	1	1	250	25	70	9125	1.0E-03	2000	1	Naphthalene	91203	128.2	3.30	1.8E-03	4.7E-02	NA	1.2E+00
				CT																		
					3300	0.5	1	219	9	70	3285	1.0E-03	2000	1	1,2-Dichloroethane	107062	99.0	1.48	1.7E-04	4.2E-03	NA	1.0E-01
					3300	0.5	1	219	9	70	3285	1.0E-03	2000	1	Benzene	71432	78.1	2.13	5.9E-04	1.5E-02	NA	3.7E-01
					3300	0.5	1	219	9	70	3285	1.0E-03	2000	1	Trichloroethene	79016	131.4	2.42	NA	1.2E-02	1.6E-02	NA
					3300	0.5	1	219	9	70	3285	1.0E-03	2000	1	Naphthalene	91203	128.2	3.30	1.8E-03	4.7E-02	NA	1.2E+00
			Cancer	RME																		
					3300	1	1	250	25	70	25550	1.0E-03	2000	1	1,2-Dichloroethane	107062	99.0	1.48	1.7E-04	4.2E-03	NA	1.0E-01
					3300	1	1	250	25	70	25550	1.0E-03	2000	1	Benzene	71432	78.1	2.13	5.9E-04	1.5E-02	NA	3.7E-01
					3300	1	1	250	25	70	25550	1.0E-03	2000	1	Trichloroethene	79016	131.4	2.42	NA	1.2E-02	1.6E-02	NA
					3300	1	1	250	25	70	25550	1.0E-03	2000	1	Naphthalene	91203	128.2	3.30	1.8E-03	4.7E-02	NA	1.2E+00
				CT																		
					3300	0.5	1	219	9	70	25550	1.0E-03	2000	1	1,2-Dichloroethane	107062	99.0	1.48	1.7E-04	4.2E-03	NA	1.0E-01
					3300	0.5	1	219	9	70	25550	1.0E-03	2000	1	Benzene	71432	78.1	2.13	5.9E-04	1.5E-02	NA	3.7E-01
					3300	0.5	1	219	9	70	25550	1.0E-03	2000	1	Trichloroethene	79016	131.4	2.42	NA	1.2E-02	1.6E-02	NA
					3300	0.5	1	219	9	70	25550	1.0E-03	2000	1	Naphthalene	91203	128.2	3.30	1.8E-03	4.7E-02	NA	1.2E+00

TABLE 5-1. DERMALLY ABSORBED DOSE CALCULATIONS - GROUNDWATER
(Variable Definitions follow Table)

Exposure Point	Timeframe	Receptor	Cancer/ Non-cancer	RME/ CT	Derm/Drink Kp	Chem Assess	B	tau (hr)	t_star (hr)	FA for tau>3	Conc mg/cm3	DA_event mg/cm2-evt	DAD mg/kg-day	log(Ds/lsc)	Dsc/lsc	Dsc	b	c	t_star1 B>0.6	t_star3 B<=0.6
Study Area	Future	Indust. Worker	Non-cancer	RME																
					1%	N	0.016	**0.38**	0.90	1.0	2.1E-06	**1.6E-08**	**5.1E-07**	-3.35E+00	4.42E-04	**4.42E-07**	3.1E-01	3.4E-01	N/A	0.90
					4%	N	0.051	**0.29**	0.69	1.0	2.4E-03	**5.5E-05**	**1.8E-03**	-3.24E+00	5.79E-04	**5.79E-07**	3.3E-01	3.7E-01	N/A	0.69
					4%	N	0.051	**0.57**	1.37	1.0	9.5E-06	**2.3E-07**	**7.4E-06**	-3.54E+00	2.91E-04	**2.91E-07**	3.4E-01	3.7E-01	N/A	1.37
					16%	Y	0.2	**0.55**	1.32	1.0	2.8E-05	**2.7E-06**	**8.7E-05**	-3.52E+00	3.03E-04	**3.03E-07**	4.4E-01	4.8E-01	N/A	1.32
				CT																
					1%	N	0.016	**0.38**	0.90	1.0	2.1E-06	**1.1E-08**	**3.0E-07**	-3.35E+00	4.42E-04	**4.42E-07**	3.1E-01	3.4E-01	N/A	0.90
					3%	N	0.051	**0.29**	0.69	1.0	2.4E-03	**3.7E-05**	**1.1E-03**	-3.24E+00	5.79E-04	**5.79E-07**	3.3E-01	3.7E-01	N/A	0.69
					3%	N	0.051	**0.57**	1.37	1.0	9.5E-06	**1.6E-07**	**4.6E-06**	-3.54E+00	2.91E-04	**2.91E-07**	3.4E-01	3.7E-01	N/A	1.37
					11%	Y	0.2	**0.55**	1.32	1.0	2.8E-05	**1.9E-06**	**5.4E-05**	-3.52E+00	3.03E-04	**3.03E-07**	4.4E-01	4.8E-01	N/A	1.32
			Cancer	RME																
					1%	N	0.016	**0.38**	0.90	1.0	2.1E-06	**1.6E-08**	**1.8E-07**	-3.35E+00	4.42E-04	**4.42E-07**	3.1E-01	3.4E-01	N/A	0.90
					4%	N	0.051	**0.29**	0.69	1.0	2.4E-03	**5.5E-05**	**6.4E-04**	-3.24E+00	5.79E-04	**5.79E-07**	3.3E-01	3.7E-01	N/A	0.69
					4%	N	0.051	**0.57**	1.37	1.0	9.5E-06	**2.3E-07**	**2.7E-06**	-3.54E+00	2.91E-04	**2.91E-07**	3.4E-01	3.7E-01	N/A	1.37
					16%	Y	0.2	**0.55**	1.32	1.0	2.8E-05	**2.7E-06**	**3.1E-05**	-3.52E+00	3.03E-04	**3.03E-07**	4.4E-01	4.8E-01	N/A	1.32
				CT																
					1%	N	0.016	**0.38**	0.90	1.0	2.1E-06	**1.1E-08**	**3.9E-08**	-3.35E+00	4.42E-04	**4.42E-07**	3.1E-01	3.4E-01	N/A	0.90
					3%	N	0.051	**0.29**	0.69	1.0	2.4E-03	**3.7E-05**	**1.4E-04**	-3.24E+00	5.79E-04	**5.79E-07**	3.3E-01	3.7E-01	N/A	0.69
					3%	N	0.051	**0.57**	1.37	1.0	9.5E-06	**1.6E-07**	**5.9E-07**	-3.54E+00	2.91E-04	**2.91E-07**	3.4E-01	3.7E-01	N/A	1.37
					11%	Y	0.2	**0.55**	1.32	1.0	2.8E-05	**1.9E-06**	**7.0E-06**	-3.52E+00	3.03E-04	**3.03E-07**	4.4E-01	4.8E-01	N/A	1.32

DERMAL ABSORPTION CALCULATION EXAMPLE

Note: This EPA spreadsheet utilized as basis for Table 5-1 calculations.

FOR ORGANIC CHEMICALS IN WATER (updated on 11/99)

Worksheet to Calculate Dermal Absorption of Organic Chemicals from Aqueous Media (updated 11/99)

Enter the Following Exposure Conditions: for site specific conditions, change values in Cells G5-G18

Concentration (mg/L*L/1000 cm3):	Conc =	1.0E-03	mg/cm3 (default value for purpose of illustration)
Input site specific concentrations in Column marked "Conc"		= 1 mg/L (1 ppm)	= 1 ug/cm3 = 1000 ppb
Area exposed (cm2):	A =	5672.0	cm2
Event time (hr/event):	t_event =	0.5	hr/event (35 minutes/event)
Event frequency (events/day):	EV =	1.0	event/day
Exposure frequency (days/year):	EF =	26.0	days/yr
Exposure duration (years):	ED =	7.0	years
Body weight (kg):	BW =	70.0	kg
Averaging time (days):	AT =	2555.0	days
for carcinogenic effects, AT=70 years (25,550 days)			
for noncarcinogenic effects, AT=ED (in days)			
Skin thickness (assumed to be 10 um):	lsc =	1.0E-03	cm

Default conditions for screening purposes:

Compare Dermal to Drinking: Adults showering for 35 minutes/day, compared to drinking 2L water/day

Dermal (mg/day) = DA_event * A * EV	IR =	2000.0	(cm3/day = L/day * 1000 cm3/L)
Drinking (mg/day) = Conc * IR * ABSIG	ABSGI =	1.0	(assumed 100% GI absorption)

IR: Ingestion rate of drinking water
ABSIG: Absorption fraction in GI tract

Refer to Appendix A for equations to evaluate DA_event and DAD

(*): outside of the Effective Prediction Domain (EPD) determined by the Flynn's measured Kp data

95% LCI and UCI are evaluated by Dr. Paul Pinsky in NCEA using SAS

	CHEMICAL	CAS No.	MWT	logKow	Kp 95% LCI	Kp (cm/hr) predicted	Kp (cm/hr) measured	Kp 95% UCI	Chemicals outside EPD (*)	Derm/ Drink Kp	Chem Assess	B	tau (hr)	t_star (hr)
118	Heptachlor	76448	373.5	4.27	3.4E-04	8.6E-03		2.2E-01		**14%**	Y	0.1	**12.99**	31.16

FA for tau>3	Conc (mg/cm3)	DA_event (mg/cm2-evt)	DAD (mg/kg-day)	log(Ds/lsc)	Dsc/lsc	Dsc	b	c	t_star1 B>0.6	t_star3 B<=0.6
0.8	1.4E-09	**6.8E-11**	**3.9E-10**	-4.89E+00	1.28E-05	**1.28E-08**	3.4E-01	3.8E-01	#NUM!	31.16

TABLE 5-2. SHOWER MODEL
FOSTER AND CHROSTOWSKI
Future Adult Scenario - Study Area Groundwater in Car Wash

	Estimation of Gas-Phase Mass Transfer Coefficient (cm/hr) $k_{g(VOC)}$			Estimation of Liquid-Phase Mass Transfer Coefficient (cm/hour) $k_{l(VOC)}$			Estimation of Overall Mass Transfer Coefficient (cm/hr) K_L			Temperature Adjusted Overall Mass Transfer Coefficient (cm/hr) -- K'L K'_L					Maximum Concentration Leaving the Shower Droplet C_{wd}				VOC Generation Rate in the Shower Room S			VOC Air Concentration in the Shower Room (for t <= D_S) $C_a(t)$			
	$k_{g(VOC)} = k_{g\ (H20)} (18 / MW)^{0.5}$			$k_{l(VOC)} = k_{l(CO2)} (44 / MW)^{0.5}$			$K_L = (1/k_{l(VOC)} + RT / H k_{g(VOC)})^{-1}$			$K'_L = K_L (T_l u_s / T_s u_l)^{-0.5}$					$C_{wd} = C_{wo} (1 - exp [-K_{al} t_s / 60 d])$				$S = C_{wd} (FR) / SV$			$C_a(t) = (S/R) (1 - exp[-R t])$			
	$k_{g\ (H20)}$	MW	$k_{g(VOC)}$	$k_{l\ (CO2)}$	MW	$k_{l(VOC)}$	H	RT	K_L	T_l	Ts	u_l	u_s	K'_L	C_{wo}	t_s	d	C_{wd}	FR	SV	S	R	D_s	t	$C_a(t)$
Analyte	cm/hr	g/mole	cm/hr	cm/hr	g/mole	cm/hr	atm-m^3/mole	atm-m^3/mole	cm/hr	K	K	cp	cp	cm/hr	ug/L	sec	mm	ug/L	l/min	m^3	ug/m^3-min	min^{-1}	min	min	mg/m^3
1,2-Dichloroethane	3.00E+03	9.90E+01	1.28E+03	2.00E+01	9.90E+01	1.33E+01	1.16E-03	2.40E-02	1.10E+01	2.93E+02	3.18E+02	1.00E+00	5.96E-01	1.48E+01	2.13E+00	2.00E+00	1.00E+00	8.29E-01	1.00E+01	6.00E+00	1.38E+00	8.33E-03	1.50E+01	5.00E+00	6.77E-03
Benzene	3.00E+03	7.81E+01	1.44E+03	2.00E+01	7.81E+01	1.50E+01	5.45E-03	2.40E-02	1.44E+01	2.93E+02	3.18E+02	1.00E+00	5.96E-01	1.93E+01	2.39E+03	2.00E+00	1.00E+00	1.14E+03	1.00E+01	6.00E+00	1.89E+03	8.33E-03	1.50E+01	5.00E+00	9.27E+00
Trichloroethene	3.00E+03	1.31E+02	1.11E+03	2.00E+01	1.31E+02	1.16E+01	9.68E-03	2.40E-02	1.13E+01	2.93E+02	3.18E+02	1.00E+00	5.96E-01	1.52E+01	9.47E+00	2.00E+00	1.00E+00	3.77E+00	1.00E+01	6.00E+00	6.28E+00	8.33E-03	1.50E+01	5.00E+00	3.07E-02
Naphthalene	3.00E+03	1.28E+02	1.12E+03	2.00E+01	1.28E+02	1.17E+01	4.32E-04	2.40E-02	7.42E+00	2.93E+02	3.18E+02	1.00E+00	5.96E-01	1.00E+01	2.84E+01	2.00E+00	1.00E+00	8.05E+00	1.00E+01	6.00E+00	1.34E+01	8.33E-03	1.50E+01	5.00E+00	6.57E-02

Notes:

MW = Molecular weight (g/mole)
$k_{g\ (H20)}$ = Gas phase mass transfer coefficient for H_20 (cm/hr)
$k_{g(VOC)}$ = Gas-phase mass-transfer coefficient for the analyte (cm/hr)
$k_{l\ (CO2)}$ = Liquid phase mass transfer coefficient for CO_2 (cm/hr)
$k_{l(VOC)}$ = Liquid-phase mass-transfer coefficient for the analyte (cm/hr)
H = Henry's Law Constant (atm-m^3/mole)
RT = Gas constant-temp factor (atm-m^3/mole)
K_L = Overall Mass-Transfer Coefficient (cm/hr)
T_l = Calibration water temperature of K_L (K)
Ts = Shower water temperature (range 300-320 K)
u_l = Water viscosity at T_l (at 20 C), centipoise (cp)
u_s = Water viscosity at T_s (at 45 C), centipoise (cp)

K'_L = Temp adjusted mass-transfer coefficient (cm/hr)
C_{wo} = Shower water concentration (tap water conc. - ug/L)
t_s = Shower droplet drop time (sec)
d = Shower droplet diameter (millimeters, mm)
C_{wd} = Concentration leaving shower droplet after time t_s (ug/L)
FR = Shower water flow rate (liters/minute, l/m)
SV = Shower room air volume (m^3)
S = VOC generation rate in the shower room (ug/m^3-min)
R = Air exchange rate (min-1)
D_s = Shower duration (min)
t = time (min)
$C_a(t)$ = Time dependent indoor concentration

TABLE 5-3. INDUSTRIAL WORKER AIR MODEL ASSUMPTIONS

Project	MSGRP FS	Acct. No.		Page	1 of 1
Subject	Industrial Worker Air Model	Comptd. By		Date	
Detail	Assumptions and Results	Ck'd By		Date	

J:\NE\WELLSG&H\FS\Comprehensive PRG backup\[Human Health Tables3.xls]Industrial Model Results (2)

Description

A potential future use of site groundwater is as process water in an industrial facility. Conservative assumptions on water use rates, process tank dimensions/characteristics, and building ventilation rate must be made. Following assumption generation, the water fate model, Toxchem+, is used to estimate contaminant flux rates from the water to the building air. These flux rates are converted to indoor air concentrations using the assumptions noted above.

Assumptions

Groundwater Influent Rate:		100	gpm =	0.144	MGD
Tank Size:	width:	10	ft		
(Mixed Tank)	length:	10	ft		
	depth:	10	ft		
Building Ventilation Rate:		5000	cfm	203904	m^3/d

[divide g/d by vent. rate to get indoor air concentration]

Results from Toxchem+ for 95% UCL influent concentrations

	g/d	ug/m^3
Study Area Groundwater:		
1,2-Dichloroethane	1.1	5.6
Benzene	1303	6392
Trichloroethene	5.2	25
Naphthalene	15	74

METCALF & EDDY

TABLE 6. HUMAN HEALTH PRELIMINARY REMEDIATION GOALS (PRGs)

Medium	Location/COC	PRGs				Additional Information				
		ILCR				Site-specific Range			MADEP Regional	
		10^{-6}	10^{-5}	10^{-4}	HQ = 1	of Background Levels	Mean	95%UCL	Background	MCLs
Sediment - mg/kg (Recreational Scenario)	**CB-03**									
	Arsenic	4	40	400	230	3.8 - 40.6	21	33	- -	- -
	WH, NT-3, 13/TT-27									
	Arsenic	5.0	50	500	300	3.8 - 40.6	21	33	- -	- -
	Benzo(a)pyrene	0.4	4	40	N/A	0.13 - 5.5	1.3	4.9	- -	- -
Sediment Cores - mg/kg (Dredging Scenario)	**SC02, SC05, SC06, SC08**									
	Arsenic	30	300	3000	400	3.8 - 40.6	21	33	- -	- -
Surface and Subsurface Soil - mg/kg (Day Care Child Scenario)	**Former Mishawum Lake Bed Area**									
	Arsenic	1	10	100	50	- -	- -	- -	20	- -
Subsurface Soil - mg/kg (Construction Worker Scenario)	**Former Mishawum Lake Bed Area**									
	Arsenic	40	400	4000	300	- -	- -	- -	20	- -
Shallow Groundwater - ug/L (Construction Worker Scenario)	**Site-wide**									
	Arsenic	200	2000	20000	1200	- -	- -	- -	5.5	10
Groundwater - ug/L (Process Water Scenario)	**Site-wide**									
	1,2-Dichloroethane	0.2	2	20	8	- -	- -	- -	- -	5
	Benzene	0.6	6	60	50	- -	- -	- -	- -	5
	Trichloroethene	0.04	0.4	4	70	- -	- -	- -	- -	5
	Naphthalene	N/A	N/A	N/A	5	- -	- -	- -	- -	- -
	Arsenic	4	40	400	600	- -	- -	- -	5.5	10
Groundwater - ug/L (Car Wash Scenario)	**Site-wide**									
	1,2-Dichloroethane	0.2	2	20	7	- -	- -	- -	- -	5
	Benzene	0.4	4	40	30	- -	- -	- -	- -	5
	Trichloroethene	0.03	0.3	3	50	- -	- -	- -	- -	5
	Naphthalene	N/A	N/A	N/A	6	- -	- -	- -	- -	- -

Notes

N/A - Not carcinogenic, or a carcinogen was not evaluated for potential non-carcinogenic effects

APPENDIX B

COSTING INFORMATION FOR REMEDIAL ALTERNATIVES

TABLE SS-2
ALTERNATIVE SS-2 CAPITAL COSTS
MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0 Pre-Design Investigation						
1.1	Mobilization/Demobilization	1	LS	$1,000.00	$1,000	[1]
1.2	Sampling Equipment	1	LS	$2,000.00	$2,000	[1]
1.3	Sampling Labor (2 workers, 2 weeks, 50 HR/WK)	200	HR	$85.00	$17,000	[1]
1.4	Direct Push Borings - Geoprobe per day	10	DAY	$1,200.00	$12,000	TDS, 2005
1.5	Soil Sample Collection	300	LF	$2.00	$600	TDS, 2005
1.6	Field XRF Analysis - Rental Charge	2	WK	$1,700.00	$3,400	Niton, 2005
1.7	Laboratory Analysis (20% for confirmation)	60	EA	$50.00	$3,000	[1]
1.8	IDW Transportation/Disposal	4	DRUM	$285.00	$1,140	[1]
1.9	Reporting	100	HR	$100.00	$10,000	[1]
	Subtotal				**$50,140**	
2.0 Institutional Controls						
2.1	Legal Fees, Deed Restrictions, Property Surveys	5	EA	$20,000	$100,000	[1]
	Subtotal				**$100,000**	
TOTAL DIRECT COSTS					**$150,140**	
3.0 Other Costs						
3.1	Project Management (8%)				$12,011	OSWER 9355.0-75
3.2	Contingency (15%)				$22,521	OSWER 9355.0-75
TOTAL OTHER COSTS					**$34,532**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE SS-2					**$184,672**	

Notes:

[1] Best estimate based on previous experience.

Costs to install monitoring wells for the groundwater monitoring program are not included in the cost estimate for SS-2. These costs would be incurred during implementation of either Alternative SUB-2 or SUB-3.

TABLE SS-2-OM
ALTERNATIVE SS-2 OPERATIONS AND MAINTENANCE COSTS
MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual O&M Costs						
OM.1.1	Periodic Inspections (Quarterly)	40	HR	$100	$4,000	[1]
OM.1.2	Inspection Reports (Quarterly)	4	EA	$5,000	$20,000	[1]
	Subtotal				**$24,000**	
TOTAL ANNUAL O&M COSTS					**$24,000**	
OM.2.0 Other Costs						
OM.2.1	Project Management (10%)				$2,400	OSWER 9355.0-75
OM.2.2	O&M Contingency (15%)				$3,600	OSWER 9355.0-75
TOTAL OTHER O&M COSTS					**$6,000**	
ANNUAL O&M COSTS ALTERNATIVE SS-2					**$30,000**	

Notes:

Present worth analysis includes periodic cost of $20,000 for preparation of five-year review.

Groundwater monitoring costs were not included in the O&M costs for SS-2 since they would be incurred during O&M for SUB-2 or SUB-3.

[1] Best estimate based on previous experience.

TABLE SS-2-PW
ALTERNATIVE SS-2 PRESENT WORTH ANALYSIS
MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$184,672	0	$0	$184,672	7.0%	1.000	$184,672
1	$0	$30,000	$0	$30,000	7.0%	0.935	$28,037
2	$0	$30,000	$0	$30,000	7.0%	0.873	$26,203
3	$0	$30,000	$0	$30,000	7.0%	0.816	$24,489
4	$0	$30,000	$0	$30,000	7.0%	0.763	$22,887
5	$0	$30,000	$20,000	$50,000	7.0%	0.713	$35,649
6	$0	$30,000	$0	$30,000	7.0%	0.666	$19,990
7	$0	$30,000	$0	$30,000	7.0%	0.623	$18,682
8	$0	$30,000	$0	$30,000	7.0%	0.582	$17,460
9	$0	$30,000	$0	$30,000	7.0%	0.544	$16,318
10	$0	$30,000	$20,000	$50,000	7.0%	0.508	$25,417
11	$0	$30,000	$0	$30,000	7.0%	0.475	$14,253
12	$0	$30,000	$0	$30,000	7.0%	0.444	$13,320
13	$0	$30,000	$0	$30,000	7.0%	0.415	$12,449
14	$0	$30,000	$0	$30,000	7.0%	0.388	$11,635
15	$0	$30,000	$20,000	$50,000	7.0%	0.362	$18,122
16	$0	$30,000	$0	$30,000	7.0%	0.339	$10,162
17	$0	$30,000	$0	$30,000	7.0%	0.317	$9,497
18	$0	$30,000	$0	$30,000	7.0%	0.296	$8,876
19	$0	$30,000	$0	$30,000	7.0%	0.277	$8,295
20	$0	$30,000	$20,000	$50,000	7.0%	0.258	$12,921
21	$0	$30,000	$0	$30,000	7.0%	0.242	$7,245
22	$0	$30,000	$0	$30,000	7.0%	0.226	$6,771
23	$0	$30,000	$0	$30,000	7.0%	0.211	$6,328
24	$0	$30,000	$0	$30,000	7.0%	0.197	$5,914
25	$0	$30,000	$20,000	$50,000	7.0%	0.184	$9,212
26	$0	$30,000	$0	$30,000	7.0%	0.172	$5,166
27	$0	$30,000	$0	$30,000	7.0%	0.161	$4,828
28	$0	$30,000	$0	$30,000	7.0%	0.150	$4,512
29	$0	$30,000	$0	$30,000	7.0%	0.141	$4,217
30	$0	$30,000	$20,000	$50,000	7.0%	0.131	$6,568
TOTAL	**$184,672**	**$900,000**	**$120,000**	**$1,204,672**			**$600,100**

TABLE SS-2-A
ALTERNATIVE SS-2 COST ASSUMPTIONS
MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
CAPITAL COSTS (TABLE SS-2)		
General Assumptions		
	Alternative SS-2 involves the imposition of institutional controls on each of the properties that are located within the contaminated surface soil area that is depicted on Figure 2-3a of the FS. For the purposes of estimating cost for the FS, it was assumed that five properties would be impacted by this alternative. A pre-design investigation (PDI) would be performed to more accurately delineate the extent of surface soil containing arsenic in excess of the surface soil PRG (50 mg/kg). Based on data that is collected during the PDI, additional properties may be subject to institutional controls in order to provide adequate protection to human health from risks associated with arsenic in soil.	
1.0 Pre-Design Investigation		
	For the purpose of estimating costs for the FS, the Pre-Design Investigation that would be performed under this alternative was assumed to consist of the advancement of approximately 100 direct-push technology (DPT) soil borings throughout the Mishawum Lake bed to determine the lateral extent of surface soil containing arsenic in excess of its PRG (50 mg/kg).	
	Each soil boring was assumed to extend three feet below ground surface, for a total drilling quantity of 300 LF. The rate of soil boring advancement (including soil sample collection, sample processing, sample analysis, and sample shipping) was assumed to be 10 soil borings per day, which translates to 10 days (2 weeks) to perform the investigation. The cost estimates presented in this section are based on these general assumptions.	
1.1	Mobilization/Demobilization	Assumes mob/demob of drilling rig, sampling equipment/supplies, and all labor required to perform investigation. Less than 50 mile mob/demob distance assumed.
1.2	Sampling Equipment	Sampling equipment includes weekly rental or purchase of the following items: pickup truck/van, photoionization detector, sampling tools, sample containers, and decontamination equipment/supplies. Shipping and handling of XRF unit included.
1.3	Sampling Labor	Sampling labor estimate assumes two samplers working two weeks (10 days) at 50 hours/week. Total = 200 hours.
1.4	Direct Push Borings	GeoProbe per day cost estimate based on vendor quote for similar project.
1.5	Soil Sample Collection	Soil sample collection cost estamate based on vendor quote for similar project.
1.6	Field XRF Analysis - Rental Charge	Weekly rental of Niton Xli 702 model x-ray fluorescence unit at $1,700 based on quote from Niton Corporation.
1.7	Laboratory Analysis	Assume 20 percent of field samples would be preserved and shipped to a fixed lab for confirmatory analysis.
1.8	IDW Transportation/Disposal	Assume 100 four-inch soil borings with 3-foot depth would create approximately 200 gallons of soil IDW, which would require off-site transportation/disposal of four 55-gallon drums. $285/drum based on previous experience with similar projects.
1.9	Reporting	Assume 100 hours for report preparation to document the findings of the PDI.
2.0 Institutional Controls		
2.1	Legal Fees, Deed Restrictions, Property Surveys	Legal fees associated with drafting and implementing deed restrictions, costs to perform property surveys at $20,000 per property.
OPERATIONS AND MAINTENANCE COSTS (TABLE SS-2-OM)		
OM.1.0 Annual O&M Costs		
OM.1.1	Periodic Inspections (Quarterly)	Assume 10 hours per quarter for inspections to verify the effectiveness of institutional controls at preventing exposure to surface soils in the former Mishawum Lake bed.
OM.1.2	Inspection Reports (Quarterly)	Assume $5000 per quarter for the preparation of inspection reports to document quarterly inspection activities and findings.

TABLE SS-3
ALTERNATIVE SS-3 CAPITAL COSTS
PERMEABLE COVER WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0	**Pre-Design Investigation**					
1.1	Mobilization/Demobilization	1	LS	$1,000.00	$1,000	[1]
1.2	Sampling Equipment	1	LS	$2,000.00	$2,000	[1]
1.3	Sampling Labor (2 workers, 2 weeks, 50 HR/WK)	200	HR	$85.00	$17,000	[1]
1.4	Direct Push Borings - Geoprobe per day	10	DAY	$1,200.00	$12,000	TDS, 2005
1.5	Soil Sample Collection	300	LF	$2.00	$600	TDS, 2005
1.6	Field XRF Analysis - Rental Charge	2	WK	$1,700.00	$3,400	Niton, 2005
1.7	Laboratory Analysis (20% for confirmation)	60	EA	$50.00	$3,000	[1]
1.8	IDW Transportation/Disposal	4	DRUM	$285.00	$1,140	[1]
1.9	Reporting	100	HR	$100.00	$10,000	[1]
	Subtotal				**$50,140**	
2.0	**Institutional Controls**					
2.1	Legal Fees, Deed Restrictions, Property Surveys	5	EA	$20,000	$100,000	[1]
	Subtotal				**$100,000**	
3.0	**Mobilization/Demobilization**					
3.1	Equipment/Labor Mobilization/Demobilization	1	LS	$20,000	$20,000	[1]
3.2	Field Support Facilities	1	LS	$3,200	$3,200	[1]
3.3	Monthly Costs associated with Field Support	3	MONTH	$2,750	$8,250	[1]
	Subtotal				**$31,450**	
4.0	**Site Preparation**					
4.1	Site Survey	1	LS	$5,000	$5,000	[1]
4.2	Construct Equipment Decontamination Pad	1	LS	$7,500	$7,500	Means 2004 HC
4.3	Construct Soil Stockpiling Area	1	LS	$2,500	$2,500	Means 2004 HC
4.4	Install Erosion and Sedimentation Controls	2,000	LF	$3.73	$7,460	Means 2004 HC, 02370 700 1250
	Subtotal				**$22,460**	
5.0	**Excavate and Stockpile Surficial Soils**					
5.1	Excavate and Load Soil into Trucks	5,500	CY	$2.29	$12,595	Means 2004 ER, 17 03 0277
5.2	Haul Soil to Stockpile Area (20% bulking factor)	6,600	CY	$3.39	$22,374	Means 2004 HC, 02315 490 0320
5.3	Dust Suppression (hourly passes over excavation area)	785	MSF	$1.31	$1,028	Means 2004 ER, 33 08 0585
5.4	Perimeter Air Samples (4 per work day)	40	EA	$25.00	$1,000	Aero-Tech, 2005
5.5	Equipment Decontamination (for duration of excavation)	785	HR	$39.56	$31,041	Means 2004 ER, 33 17 0823
	Subtotal				**$68,038**	
6.0	**Transportation and Off-Site Disposal of Soil**					
6.1	Load Waste into Trucks	6,600	CY	$2.29	$15,114	Means 2004 ER, 17 03 0277
6.2	Equipment Decontamination	88	HR	$39.56	$3,481	Means 2004 ER, 33 17 0823
6.3	Transportation of Contaminated Soil	9,900	TON	$89.00	$881,100	Boston Environmental, 2005
6.4	Off-Site Disposal of Soil	9,900	TON	$239.00	$2,366,100	Boston Environmental, 2005
	Subtotal				**$3,265,795**	
7.0	**Construction of Permeable Cover**					
7.1	Place Geotextile	100,000	SF	$0.25	$25,222	Means 2004 HC, 02340 300 1500
7.2	Gravel Backfill, Delivered, Spread, and Compacted	4,400	CY	$10.95	$48,180	Means 2004 ER, 17 03 0430
7.3	Topsoil, Furnished and Placed	2,200	CY	$26.95	$59,290	Means 2004 ER, 18 05 0301
7.4	Seeding	100,000	SF	$0.09	$9,000	Means 2004 ER, 18 05 0402
7.5	Minor Repairs to Existing Asphalt	10,000	SF	$1.17	$11,700	Means 2004 HC, 02740 315 1100
	Subtotal				**$153,392**	
8.0	**Site Restoration**					
8.1	Decon Pad Demo and Disposal	1	LS	$2,000.00	$2,000	[1]
8.2	Demob Support Facilities	1	LS	$2,500.00	$2,500	[1]
8.3	Restore Laydown and Stockpile Areas	1	LS	$5,000.00	$5,000	[1]
	Subtotal				**$9,500**	
TOTAL DIRECT COSTS					**$3,700,776**	

TABLE SS-3
ALTERNATIVE SS-3 CAPITAL COSTS
PERMEABLE COVER WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
9.0 Other Costs						
9.1	Project Management (5%)				$185,039	OSWER 9355.0-75
9.2	Engineering and Design (8%)				$296,062	OSWER 9355.0-75
9.3	Construction Management (6%)				$222,047	OSWER 9355.0-75
9.4	Location Adustment (10%)				$370,078	Means 2004 ER
9.5	Contingency (15%)				$555,116	OSWER 9355.0-75
TOTAL OTHER COSTS					**$1,628,341**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE SS-3					**$5,329,117**	

Notes:
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE SS-3-OM
ALTERNATIVE SS-3 OPERATIONS AND MAINTENANCE COSTS
PERMEABLE COVER WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual O&M Costs						
OM.1.1	Labor - Periodic Inspections (Quarterly)	40	HR	$100.00	$4,000	[1]
OM.1.2	Cap Maintenance (Assume 10% cap area per year)					
1.2.1	Topsoil, Furnished and Placed	220	CY	$26.95	$5,929	Means 2004 ER, 18 05 0301
1.2.2	Seeding	10,000	SF	$0.09	$900	Means 2004 ER, 18 05 0402
1.2.3	Maintenance Labor	32	HR	$85.00	$2,720	[1]
OM.1.3	Asphalt Maintenance	4,300	SF	$1.17	$5,031	Means 2004 HC, 02740 315 1100
OM.1.4	Reporting (Quarterly)	4	LS	$5,000.00	$20,000	[1]
	Subtotal				**$38,580**	
TOTAL ANNUAL O&M COSTS					**$38,580**	
OM.2.0 Other Costs						
OM.2.1	Project Management (10%)				$3,858	OSWER 9355.0-75
OM.2.2	O&M Contingency (15%)				$5,787	OSWER 9355.0-75
TOTAL OTHER O&M COSTS					**$9,645**	
ANNUAL O&M COSTS ALTERNATIVE SS-3					**$48,225**	

Notes:

[1] Best estimate based on previous experience.

Present worth analysis includes periodic cost of $30,000 for preparation of five-year review.

TABLE SS-3-PW
ALTERNATIVE SS-3 PRESENT WORTH ANALYSIS
PERMEABLE COVER WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$5,329,117	0	$0	$5,329,117	7.0%	1.000	$5,329,117
1	$0	$48,225	$0	$48,225	7.0%	0.935	$45,070
2	$0	$48,225	$0	$48,225	7.0%	0.873	$42,122
3	$0	$48,225	$0	$48,225	7.0%	0.816	$39,366
4	$0	$48,225	$0	$48,225	7.0%	0.763	$36,791
5	$0	$48,225	$30,000	$78,225	7.0%	0.713	$55,773
6	$0	$48,225	$0	$48,225	7.0%	0.666	$32,134
7	$0	$48,225	$0	$48,225	7.0%	0.623	$30,032
8	$0	$48,225	$0	$48,225	7.0%	0.582	$28,067
9	$0	$48,225	$0	$48,225	7.0%	0.544	$26,231
10	$0	$48,225	$30,000	$78,225	7.0%	0.508	$39,766
11	$0	$48,225	$0	$48,225	7.0%	0.475	$22,911
12	$0	$48,225	$0	$48,225	7.0%	0.444	$21,412
13	$0	$48,225	$0	$48,225	7.0%	0.415	$20,012
14	$0	$48,225	$0	$48,225	7.0%	0.388	$18,702
15	$0	$48,225	$30,000	$78,225	7.0%	0.362	$28,352
16	$0	$48,225	$0	$48,225	7.0%	0.339	$16,335
17	$0	$48,225	$0	$48,225	7.0%	0.317	$15,267
18	$0	$48,225	$0	$48,225	7.0%	0.296	$14,268
19	$0	$48,225	$0	$48,225	7.0%	0.277	$13,335
20	$0	$48,225	$30,000	$78,225	7.0%	0.258	$20,215
21	$0	$48,225	$0	$48,225	7.0%	0.242	$11,647
22	$0	$48,225	$0	$48,225	7.0%	0.226	$10,885
23	$0	$48,225	$0	$48,225	7.0%	0.211	$10,173
24	$0	$48,225	$0	$48,225	7.0%	0.197	$9,507
25	$0	$48,225	$30,000	$78,225	7.0%	0.184	$14,413
26	$0	$48,225	$0	$48,225	7.0%	0.172	$8,304
27	$0	$48,225	$0	$48,225	7.0%	0.161	$7,761
28	$0	$48,225	$0	$48,225	7.0%	0.150	$7,253
29	$0	$48,225	$0	$48,225	7.0%	0.141	$6,779
30	$0	$48,225	$30,000	$78,225	7.0%	0.131	$10,276
TOTAL	**$5,329,117**	**$1,446,750**	**$180,000**	**$6,955,867**			**$5,992,278**

TABLE SS-3-A
ALTERNATIVE SS-3 COST ASSUMPTIONS
PERMEABLE COVER WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
	CAPITAL COSTS (TABLE SS-3)	
General Assumptions		
	Alternative SS-3 is a containment alternative that involves the construction of a permeable cover over contaminated surface soil areas that are currently vegetated at the surface and therefore potentially accessible to human receptors. The existing asphalt surfaces that currently occupy much of the former Mishawum Lake bed would be left in place (or improved, if necessary) so that underlying contaminated soil remains contained beneath the asphalt surface.	
	Construction of the permeable cover would involve the excavation of approximately 18 inches of contaminated soil from the vegetated areas of arsenic-contaminated surface soil identified on Table 2-3a of the FS (approximately 100,000 square feet). This soil would be stockpiled on site, characterized, and transported for disposal at an EPA-approved off-site facility. The permeable cover would consist of a geotextile overlain by 12 inches of clean gravel and inches of topsoil that would be planted with grass.	
	Alternative SS-3 would also involve the imposition of institutional controls on each of the properties that are located within the contaminated surface soil area that is depicted on Figure 2-3a of the FS. For the purposes of estimating cost for the FS, it was assumed that five properties would be impacted by this alternative. A pre-design investigation (PDI) would be performed to more accurately delineate the extent of surface soil containing arsenic in excess o the surface soil PRG (50 mg/kg). Based on data that is collected during the PDI, additional properties may be subject to institutional controls in order to provide adequate protection to human health from risks associated with arsenic in soil.	
1.0 Pre-Design Investigation		
	The pre-design investigation that would be performed under this alternative would be the same as was described for Alternative SS-2.	
	The assumptions and basis of cost estimates for the PDI are described on Table SS-2-A.	
2.0 Institutional Controls		
2.1	Legal Fees, Deed Restrictions, Property Surveys	Legal fees associated with drafting and implementing deed restrictions, costs to perform property surveys at $20,000 per property.
3.0 Mobilization/Demobilization		
	One work week (5 days) assumed for mobilization of labor and equipment for this alternative.	
3.1	Equipment/Labor Mobilization/Demobilization	Assume less than 50 mile haul distance for all equipment.
		Equipment would be mobilized and demobilized to and from the site once for this project.
3.2	Field Support Facilities	Field support facilities will be mobilized and demobilized to and from the central field support area once during the course of the project.
		The following items are included in this cost line item: office trailer @ $500, storage trailer @ $500, dumpster @ $100, sanitary facilities @ $100, soil sampling equipment @ $2000.
3.3	Monthly Costs associated with Field Support	Includes monthly rental costs for duration of project for the following: office trailer @ $400, storage trailer @ $200, utilities @ $200, dumpster @ $200, sampling materials @ $1000, air sampling equipment (PID) @ 750.
		Duration of project = Mobilization (1 week) + Site Prep (1 week) + Excavate and Stockpile (3 week) + Transportation and Disposal (2 week) + Cover Construction (5 week) + Site Restoration (1 week). 13 weeks ≈ 3 months.
4.0 Site Preparation		
4.1	Site survey	Assume $5,000 for site survey to identify sampling locations/construction areas.
4.2	Construct Decontamination Pad	Assumes construction of heavy equipment decontamination pad at location within construction area.
		Equipment decontamination pad assumed assumed 20' x 40' in size with 6" gravel base, 40 mil high density polyethylene liner, and 4" crushed stone, graded to divert decontamination fluids into a water collection sump.
	Gravel base, delivered and dumped	15 CY @ $24.51/CY = $368 [Means 2004 ER, 18 01 0102]
	40 mil polyethylene liner	800 SF @ $1.39/SF = $1,112 [Means 2004 ER, 33 08 0563]
	Stone drainage layer	270 CY @ 22.94/CY = $6,195 [Means 2004 ER, 17 03 0419]
4.3	Construct Soil Stockpiling Area	Assume one soil stockpiling area to be constructed within construction zone to provide temporary storage for excavated soil that is removed from the Mishawum Lake bed to prepare the site for permeable cover (1.5 foot deep excavation). Waste characterization soil samples will be collected from stockpiled soil to determine the appropriate off-site disposal requirements.
		Stockpiling area would be located on an existing paved area within the former Mishawum Lake bed. Soil would be stockpiled directly onto the asphalt surface. The stockpile would be covered with 6 mil poly tarps daily to prevent excessive erosion due to stormwater runoff.
		Silt fence and hay bales would be installed at the perimeter of each stockpile to prevent sedimentation that might enable contaminant transport from the stockpiles (see section 2.6).
		After completion of the remedial action, the asphalt underlying the stockpile area would be removed, recycled, and replaced with a new layer of pavement (see Site Restoration).
		100 x 100 foot area assumed for stockpile.
	Hay bails, staked	500 LF @ $2.72/CY = $1,360 [Means 2004 HC, 02370 700 1250]
	Silt fence	500 LF @ $1.01/LF = $505 [Means 2004 HC, 02370 700 1100]
	6 mil polyethylene cover tarps (60 x 60)	4 @ $150 EA = $600
4.4	Install Erosion and Sedimentation Controls	Erosion and sedimentation controls would be installed at the perimeter of all work areas where erosion and sedimentation may impact sensitive environmental areas such as wetlands, surface water bodies, etc.
	Hay bails, staked	2000 LF @ $2.72/LF = $5,440 [Means 2004 HC, 02370 700 1250
	Silt fence	2000 LF @ $1.01/LF = $2,020 [Means 2004 HC, 02370 700 1100

TABLE SS-3-A
ALTERNATIVE SS-3 COST ASSUMPTIONS
PERMEABLE COVER WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
5.0	**Excavate and Stockpile Surficial Soils**	
	Under this alternative, 1.5 feet of soil would be excavated from each of the contaminated soil areas and replaced with a geotextile and 1.5 feet of clean soil. This section presents estimated costs for the excavation of surficial soil, transportation of soil to the soil stockpiling area, and management of the stockpile. Other excavation support items and engineering controls (such as dust control, air sampling, and equipment decontamination) are also included.	
	Excavation and loading of soil from each of the contaminated soil areas (Figure 2-3a) would be accomplished using a hydraulic excavator. Excavated Raymark waste would be loaded directly into 10 CY dump trucks and transported to the soil stockpiling area (described above under Site Preparation).	
5.1	Excavate and Load Soil into Trucks	Excavate and Load, 2 CY Hydraulic Excavator, Medium Material, 75 CY/HF.
		Crew CODET: 1 laborer, 1 hydraulic excavator, 2.00 CY bucket, 1 equipment operator. Daily rate = $1,400.
		5,500 CY * 1 HR/75 CY ≈ 73 HR
5.2	Haul Waste to Stockpile Area	12 CY dump trucks, 0.5-mile round trip, 3.2 loads/hour, 250 CY/ truck/day assumed. Assume two trucks transporting soil (6.4 loads/hour) to provide capacity for 75 CY/HR excavation rate.
		Crew B-34B (2): 1 truck driver, 1 dump truck (16 ton). $850 daily rate.
		Assume bulking factor from removal of soil at 1.2. Therefore 5,500 CY soil in-situ roughly equivalent to 6,600 CY of excavated soil that will be hauled to stockpiling/staging areas.
5.3	Dust Suppression	Dust suppression assumed to occur during excavation of soil to prevent airborne migration of contaminants via fugitive dusts and particulates.
		Crew COFWI: 1 water truck w/ 3,000 gallon water tank, 1 truck driver, 1 equipment operator, 1 submersible pump (6" diameter, 1950 GPM). Daily rate = $900.
		75 CY/HR * 8 HR/DAY = 600 CY/DAY assumed excavation volume. 600 CY≈ 16,000 CF. Assume depth of excavation 1.5 feet, therefore daily excavation area≈ 16,000 CF / 1.5 LF ≈ 10,700 SF. Assume hourly passes (8 per day) for 85,600 SF/DAY or 85.6 MSF/DAY.
5.4	Perimeter Air Samples	Monitoring of site perimeter for particulates to verify effectiveness of engineering controls to prevent the spread of airborne contamination.
		Assume 4 samples per day (one at north, south, east, and west borders of work area) analyzed for arsenic (metals) at $25/sample.
5.5	Equipment Decontamination	Assume decontamination of heavy vehicles as they leave excavation area to transport excavated soil. Operate 1,800 PSI pressure washer at $39.56/HR. Includes water, soap, electricity, and labor. Assume operation during entire duration of excavation activities.
6.0	**Transportation and Off-Site Disposal of Soil**	
6.1	Load Waste into Trucks	Excavate and Load, 2 CY Hydraulic Excavator, Medium Material, 75 CY/Hour Load waste from stockpiles into 20 CY dump trailers for transportation to disposal facility.
		Crew CODET: 1 laborer (semi-skilled), 1 hydraulic excavator, crawler, 2.00 CY Bucket, 1 equipment operator. Daily rate = $1,400.
		6,600 CY * 1 HR/75 CY ≈ 88 HR.
6.2	Equipment Decontamination	Assume decontamination of heavy vehicles as they leave excavation area to transport excavated soil. Operate 1,800 PSI pressure washer at $39.56/HR. Includes water, soap, electricity, and labor. Assume operation during entire duration of excavation activities.
6.3	Transportation of Contaminated Soil	Assume transportation of excavated Raymark waste using 20 CY dump trailers. Unit cost for transportation based on quote from disposal subcontractor.
		1.5 tons per 1.0 cubic yards assumed for transportation and disposal estimates.
6.4	Off-Site Disposal of Soil	Assume disposal of waste at hazardous waste facility. Disposal cost includes full TCLP analysis (one per 500 tons of waste).
7.0	**Construction of Permeable Cover**	
	The permeable cover would consist of a geotextile fabric overlain by 12 inches of gravel and 6 inches of topsoil. The topsoil would be seeded.	
7.1	Place Geotextile	Place woven geotextile fabric, 2500 SY/DAY.
7.2	Gravel Backfill, Delivered, Dumped, Spread, and Compacted	Gravel placed in 6" lifts, includes spreading and compaction. Also includes the following: soil density test nuclear method ASTM D2922-71, compaction water price $0.005/Gallon.
		Spread Fill with dozer: 1 equipment operator, 1 labor foreman. Daily rate = $1250
		Compaction: 1 compactor, 3 semi-skilled laborers. Daily rate = $700.
		Compaction Water: 1 water truck, 1 truck driver, 1 submersible pump, 1 equipment operator. Daily rate = $800.
		Soil Density Tests: 2 skilled workers. Daily rate = $900
		4,400 CY * 1 HR/100 CY ≈ 44 HR.
7.3	Topsoil, Furnished and Placed	Topsoil furnished and placed, 6" thick. 11.5 CY/HR
		Crew CODLA: 1 equipment operator, 1 semi-skilled laborer. Daily rate = $650
		2,200 CY * 1 HR/11.5 CY ≈ 190 HR.
7.4	Seeding	Vegetative cover using mechanical seeder, power mulcher, and watering truck.
		Power mulcher: 1 highway truck, 1 power mulcher, 1 laborer, 1 truck driver. Daily rate = $700.
		Mechanical seeding: 1.25 semi-skilled laborers. Daily rate = $250.
		Watering: 1 water truck, 1 truck driver, 2 laborers. Daily rate = $900.

TABLE SS-3-A
ALTERNATIVE SS-3 COST ASSUMPTIONS
PERMEABLE COVER WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
7.4	Minor Repairs to Existing Asphalt	Assume 10,000 SF required. Hot mix, fill holes, 4" thick.
		Crew B-16: 1 dump truck, 1 truck driver, 2 laborers, 1 labor foreman. Daily rate = $1,850.
8.0 Site Restoration		
Site restoration activities would include demolition and disposal of materials from the decontamination pad, demobilization of support facilities, and restoration of stockpiling and equipment laydown areas.		
8.1	Decon Pad Demo and Disposal	Demolish and dispose of decontamination pad materials. $2000 estimate based on experience with similar projects.
8.2	Demob Support Facilities	$2500 estimate based on experience with similar projects.
8.3	Restore Laydown and Stockpile Areas	Demolish and dispose of materials. Cost estimate based on previous experience.
	OPERATIONS AND MAINTENANCE COSTS (TABLE SS-3-OM)	
OM.1.0 Annual O&M Costs		
OM.1.1	Periodic Inspections (Quarterly)	Assume 10 hours per quarter for inspections to verify the integrity of the cover and the effectiveness of institutional controls at preventing exposure to surface soils.
OM.1.2	Cap Maintenance	Assumes 10% of cover would need maintenance per year
	Topsoil, Furnished and Placed	2,200 CY * 0.1 = 220 CY.
	Seeding	100,000 SF * 0.1 = 10,000 SF.
OM.1.3	Asphalt Maintenance	Assume repairs of existing asphalt at approximately 1% of asphalt area
OM.1.4	Reporting (Quarterly)	Assume $5000 per quarter for the preparation of inspection reports to document quarterly inspection activities and findings.

TABLE SS-4
ALTERNATIVE SS-4 CAPITAL COSTS
EXCAVATION AND OFF-SITE DISPOSAL - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0	**Pre-Design Investigation**					
1.1	Mobilization/Demobilization	1	LS	$1,000.00	$1,000	[1]
1.2	Sampling Equipment	1	LS	$2,000.00	$2,000	[1]
1.3	Sampling Labor (2 workers, 2 weeks, 50 HR/WK)	200	HR	$85.00	$17,000	[1]
1.4	Direct Push Borings - Geoprobe per day	10	DAY	$1,200.00	$12,000	TDS, 2005
1.5	Soil Sample Collection	300	LF	$2.00	$600	TDS, 2005
1.6	Field XRF Analysis - Rental Charge	2	WK	$1,700.00	$3,400	Niton, 2005
1.7	Laboratory Analysis (20% for confirmation)	60	EA	$50.00	$3,000	[1]
1.8	IDW Transportation/Disposal	4	DRUM	$285.00	$1,140	[1]
1.9	Reporting	100	HR	$100.00	$10,000	[1]
	Subtotal				**$50,140**	
2.0	**Mobilization/Demobilization**					
2.1	Equipment/Labor Mobilization/Demobilization	1	LS	$20,000	$20,000	[1]
2.2	Field Support Facilities	1	LS	$3,200	$3,200	[1]
2.3	Monthly Costs associated with Field Support	11	MONTH	$2,750	$30,250	[1]
	Subtotal				**$53,450**	
3.0	**Site Preparation**					
3.1	Clear and Grub	2	ACRE	$3,150	$6,300	Means 2004 HC, 02230 100 0020
3.2	Site Survey	1	LS	$5,000	$5,000	[1]
3.3	Construct Equipment Decontamination Pad	1	LS	$7,500	$7,500	Means 2004 HC
3.4	Construct Soil Stockpiling Area	1	LS	$2,500	$2,500	Means 2004 HC
3.5	Install Erosion and Sedimentation Controls	3,000	LF	$3.73	$11,190	Means 2004 HC, 02370 700 1250
	Subtotal				**$32,490**	
4.0	**Excavate and Stockpile Surface Soils**					
4.1	Excavate and Load Soil into Trucks	53,000	CY	$2.29	$121,370	Means 2004 ER, 17 03 0277
4.2	Haul Soil to Stockpile Area	63,600	CY	$5.50	$349,800	Means 2004 HC, 02315 490 1245
4.3	Dust Suppression (hourly passes over excavation area)	3,772	MSF	$1.31	$4,941	Means 2004 ER, 33 08 0585
4.4	Perimeter Air Samples (4 per work day)	353	EA	$25.00	$8,833	Aero-Tech, 2005
4.5	Cleanup Confirmation Samples (1 per 500 CY)	106	EA	$100.00	$10,600	[1]
4.6	Equipment Decontamination (for duration of excavation)	707	HR	$39.56	$27,956	Means 2004 ER, 33 17 0823
4.7	Stockpile Management	63,600	CY	$1.32	$83,952	Means 2004 HC, 02230 500 0100
	Subtotal				**$607,452**	
5.0	**Transportation and Off-Site Disposal of Soil**					
5.1	Load Soil into Trucks	63,600	CY	$2.29	$145,644	Means 2004 ER, 17 03 0277
5.2	Equipment Decontamination	848	HR	$39.56	$33,547	Means 2004 ER, 33 17 0823
5.3	Transportation of Contaminated Soil	95,400	TON	$89.00	$8,490,600	Boston Environmental, 2005
5.4	Off-Site Disposal of Soil	95,400	TON	$239.00	$22,800,600	Boston Environmental, 2005
	Subtotal				**$31,470,391**	
6.0	**Backfill and Site Restoration**					
6.1	Gravel Backfill; Dumped, Spread, and Compacted	51,564	CY	$10.95	$564,625	Means 2004 ER, 17 03 0430
6.2	Topsoil, Furnished and Placed (4")	925	CY	$26.95	$24,929	Means 2004 ER, 18 05 0301
6.3	Seeding	75,000	SF	$0.09	$6,750	Means 2004 ER, 18 05 0402
6.4	Repave with Asphalt	400,000	SF	$1.00	$400,000	Means 2004 HC, 02740 315 0600
6.5	Decon Pad Demo and Disposal	1	LS	$2,000.00	$2,000	[1]
6.6	Demob Support Facilities	1	LS	$2,500.00	$2,500	[1]
6.7	Restore Laydown and Stockpile Areas	1	LS	$5,000.00	$5,000	[1]
	Subtotal				**$1,005,803**	
TOTAL DIRECT COSTS					**$33,219,726**	
7.0	**Other Costs**					
7.1	Project Management (5%)				$1,660,986	OSWER 9355.0-75
7.2	Engineering and Design (6%)				$1,993,184	OSWER 9355.0-75
7.3	Construction Management (6%)				$1,993,184	OSWER 9355.0-75
7.4	Location Adustment (10%)				$3,321,973	Means 2004 ER
7.5	Contingency (15%)				$4,982,959	OSWER 9355.0-75
TOTAL OTHER COSTS					**$13,952,285**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE SS-4					**$47,172,011**	

Notes:
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE SS-4-A
ALTERNATIVE SS-4 COST ASSUMPTIONS
EXCAVATION AND OFF-SITE DISPOSAL - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
	CAPITAL COSTS (TABLE SS-4)	
General Assumptions		
	Alternative SS-4 features the excavation of all surface soil (0 to 3 feet below ground surface) that contains concentrations of arsenic that exceed the PRG (50 mg/kg). Excavated soil would be stockpiled on site, characterized, and transported and disposed at an of-site EPA-approved disposal facility. Excavated areas would be backfilled with clean soil and surfaces would be restored to their current condition (either vegetated or paved).	
	Since under this alternative there would be no contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, there would be no operations and maintenance costs associated with the alternative and five-year reviews would not be conducted.	
	Alternative SS-4 would also include a pre-design investigation (PDI) to more accurately delineate the extent of surface soil containing arsenic in excess of the surface soil PRG. Based on the existing data, the proposed excavation area for surface soil removal is approximately 475,000 SF. Building footprints were not included in the estimated contaminated soil area, and no excavation of soil beneath existing buildings was assumed for the development of this cost estimate. The wetland area located between SO-09 and the Halls Brook Holding Area was not included in the surface soil excavation area.	
1.0 Pre-Design Investigation		
	The pre-design investigation that would be performed under this alternative would be the same as was described for Alternative SS-2.	
	The assumptions and basis of cost estimates for the PDI are described on Table SS-2-A.	
2.0 Mobilization/Demobilization		
	One work week (5 days) assumed for mobilization of labor and equipment for this alternative.	
2.1	Equipment/Labor Mobilization/Demobilization	Assume less than 50 mile haul distance for all equipment.
		Equipment would be mobilized and demobilized to and from the site once for this project.
2.2	Field Support Facilities	Field support facilities will be mobilized and demobilized to and from the central field support area once during the course of the project.
		The following items are included in this cost line item: office trailer @ $500, storage trailer @ $500, dumpster @ $100, sanitary facilities @ $100, soil sampling equipment @ $2000.
2.3	Monthly Costs associated with Field Support	Includes monthly rental costs for duration of project for the following: office trailer @ $400, storage trailer @ $200, utilities @ $200, dumpster @ $200, sampling materials @ $1000, air sampling equipment (PID) @ 750.
		Duration of project = Mobilization (1 week) + Site Prep (1 week) + Excavate and Stockpile (20 week) + Transportation and Disposal (4 week - overlap with excavation) + Backfill and Site Restoration (20 week - some overlap with excavation). 46 weeks ≈ 11 months.
3.0 Site Preparation		
	Site preparation for this alternative would be similar to the description presented for Alternative SS-3 (Table SS-3-OM). The only difference being that, due to the larger excavation area, the quantity of erosion and sedimentation controls would be greater.	
4.0 Excavate and Stockpile Surface Soils		
	Under this alternative, 3 feet of soil would be excavated from the contaminated soil area (Figure 2-3a) and replaced with clean soil. The ground surface would be restored to match the existing ground cover (vegetated or asphalt). This section presents estimated costs for the excavation of surface soil, transportation of soil to the soil stockpiling area, and management of the stockpile. Other excavation support items and engineering controls (such as dust control, air sampling, and equipment decontamination) are also included.	
	Excavation and loading of soil from each of the contaminated soil areas (Figure 2-3a) would be accomplished using a hydraulic excavator. Excavated Raymark waste would be loaded directly into 10 CY dump trucks and transported to the soil stockpiling area (described above under Site Preparation).	
4.1	Excavate and Load Waste	Excavate and Load, 2 CY Hydraulic Excavator, Medium Material, 75 CY/HR.
		Crew CODET: 1 laborer, 1 hydraulic excavator, 2.00 CY bucket, 1 equipment operator. Daily rate = $1,400.
		475,000 SF * 3 LF / 27 CF/CY ≈ 53,000 CY.
		53,000 CY / 75 CY/HR ≈ 700 HR.
4.2	Haul Waste to Stockpile Area	12 CY dump trucks, 0.5-mile round trip, 3.2 loads/hour, 250 CY/ truck/day assumed. Assume two trucks transporting soil (6.4 loads/hour) to provide capacity for 75 CY/HR excavation rate.
		Crew B-34B (2): 1 truck driver, 1 dump truck (16 ton). $850 daily rate.
		Assume bulking factor from removal of soil at 1.2. Therefore 53,000 CY soil in-situ roughly equivalent to 63,600 CY of excavated soil that will be hauled to stockpiling/staging areas.
4.3	Dust Suppression	Dust suppression assumed to occur during excavation of soil to prevent airborne migration of contaminants via fugitive dusts and particulates.
		Crew COFWI: 1 water truck w/ 3,000 gallon water tank, 1 truck driver, 1 equipment operator, 1 submersible pump (6" diameter, 1950 GPM). Daily rate = $900.
		75 CY/HR * 8 HR/DAY = 600 CY/DAY assumed excavation volume. 600 CY ≈ 16,000 CF. Assume depth of excavation 3 feet, therefore daily excavation area ≈ 16,000 CF / 3 ≈ 5,300 SF. Assume hourly passes (8 per day) for 42,700 SF/DAY or 42.7 MSF/day.
4.4	Perimeter Air Samples	Monitoring of site perimeter for particulates to verify effectiveness of engineering controls to prevent the spread of airborne contamination.
		Assume 4 samples per day (one at north, south, east, and west borders of work area) analyzed for arsenic (metals) at $25/sample.
4.5	Cleanup Confirmation Samples	Cleanup confirmation samples collected from sidewalls of excavation and analyzed for arsenic at $100/SAMPLE. For purposes of cost estimate, 1 sample per 500 CY excavated assumed.

TABLE SS-4-A
ALTERNATIVE SS-4 COST ASSUMPTIONS
EXCAVATION AND OFF-SITE DISPOSAL - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
4.6	Equipment Decontamination	Assume decontamination of heavy vehicles as they leave excavation area to transport excavated soil. Operate 1,800 PSI pressure washer at $39.56/HR. Includes water, soap, electricity, and labor. Assume operation during entire duration of excavation activities.
4.7	Stockpile Management	Stockpile management assumed to include stripping & stockpiling of soil at each of the stockpiling areas. Assume 200 HP dozer adverse conditions, 1150 CY/day.
		Crew B-10B: 1 equipment operator, 0.5 laborer, 1 dozer. Daily rate = $1,500.
		Stockpile management shall continue for duration of the project, therefore management of approximately 63,600 CY is assumed.
5.0 Transportation and Disposal of Raymark Waste		
5.1	Load Soil into Trucks	Excavate and Load, 2 CY Hydraulic Excavator, Medium Material, 75 CY/Hour. Load waste from stockpiles into 20 CY dump trailers for transportation to disposal facility.
		Crew CODET: 1 laborer (semi-skilled), 1 hydraulic excavator, crawler, 2.00 CY Bucket, 1 equipment operator. Daily rate = $1,400.
		63,600 CY * 1 HR/75 CY ≈ 850 HR.
5.2	Equipment Decontamination	Assume decontamination of heavy vehicles as they leave excavation area to transport excavated soil. Operate 1,800 PSI pressure washer at $39.56/HR. Includes water, soap, electricity, and labor. Assume operation during entire duration of excavation activities.
5.3	Transportation of Contaminated Soil	Assume transportation of excavated Raymark waste using 20 CY dump trailers. Unit cost for transportation based on quote from disposal subcontractor.
		1.5 tons per 1.0 cubic yards assumed for transportation and disposal estimates.
5.4	Off-Site Disposal of Soil	Assume disposal of waste at hazardous waste facility. Disposal cost includes full TCLP analysis (one per 500 tons of waste).
6.0 Backfill and Site Restoration		
Backfill and site restoration activities would include the placement and compaction of clean fill into excavations, and surface restoration in excavated areas using vegetation or asphalt. Demolition and disposal of materials from the decontamination pad, demobilization of support facilities, and restoration of stockpiling and equipment laydown areas is also included.		
6.1	Gravel Backfill; Dumped, Spread, and Compacted	Gravel placed in 6" lifts, includes spreading and compaction. Also includes the following: soil density test nuclear method ASTM D2922-71, compaction water price $0.005/Gallon.
		Spread Fill with dozer: 1 equipment operator, 1 labor foreman. Daily rate = $1250.
		Compaction: 1 compactor, 3 semi-skilled laborers. Daily rate = $700.
		Compaction Water: 1 water truck, 1 truck driver, 1 submersible pump, 1 equipment operator. Daily rate = $800.
		Soil Density Tests: 2 skilled workers. Daily rate = $900.
		51,564 CY * 1 HR/100 CY ≈ 515 HR.
6.2	Topsoil, Furnished and Placed (4")	Topsoil furnished and placed, 4" thick. 18 CY/HR.
		Crew CODLA: 1 equipment operator, 1 semi-skilled laborer. Daily rate = $650.
		925 CY * 1 HR/18 CY ≈ 50 HR.
6.3	Seeding	Vegetative cover using mechanical seeder, power mulcher, and watering truck.
		Power mulcher: 1 highway truck, 1 power mulcher, 1 laborer, 1 truck driver. Daily rate = $700.
		Mechanical seeding: 1.25 semi-skilled laborers. Daily rate = $250.
		Watering: 1 water truck, 1 truck driver, 2 laborers. Daily rate = $900.
6.4	Repave with Asphalt	Asphaltic concrete pavement, lots and driveways. 6" stone base, 2" binder course, 4" thick topping.
		Crew B-25C: 1 asphalt paver, 1 roller, 2 equipment operators, 1 labor foreman, 3 laborers. Daily rate = $4000.
		400,000 SF / 10,800 SF/day ≈ 35 days.
6.5	Decon Pad Demo and Disposal	Demolish and dispose of decontamination pad materials. $2000 estimate based on experience with similar projects.
6.6	Demob Support Facilities	$2500 estimate based on experience with similar projects.
6.7	Restore Laydown and Stockpile Areas	Demolish and dispose of materials. Cost estimate based on previous experience.

TABLE SS-5
ALTERNATIVE SS-5 CAPITAL COSTS
EXCAVATION, TREATMENT, AND ON-SITE REUSE - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0 Pre-Design Investigation						
1.1	Mobilization/Demobilization	1	LS	$1,000.00	$1,000	[1]
1.2	Sampling Equipment	1	LS	$2,000.00	$2,000	[1]
1.3	Sampling Labor (2 workers, 2 weeks, 50 HR/WK)	200	HR	$85.00	$17,000	[1]
1.4	Direct Push Borings - Geoprobe per day	10	DAY	$1,200.00	$12,000	TDS, 2005
1.5	Soil Sample Collection	300	LF	$2.00	$600	TDS, 2005
1.6	Field XRF Analysis - Rental Charge	2	WK	$1,700.00	$3,400	Niton, 2005
1.7	Laboratory Analysis (20% for confirmation)	60	EA	$50.00	$3,000	[1]
1.8	IDW Transportation/Disposal	4	DRUM	$285.00	$1,140	[1]
1.9	Reporting	100	HR	$100.00	$10,000	[1]
	Subtotal				**$50,140**	
2.0 Mobilization/Demobilization						
2.1	Equipment Mobilization	1	LS	$20,000	$20,000	[1]
2.2	Field Support Facilities	1	LS	$3,200	$3,200	[1]
2.3	Monthly Costs associated with Field Support	14	MONTH	$3,000	$42,000	[1]
	Subtotal				**$65,200**	
3.0 Site Preparation						
3.1	Site Access Road Construction	0	SY	$12.55	$0	Means 2004 HC, 02720 200 0300
3.2	Clear and Grub	2	ACRE	$3,150	$6,300	Means 2004 HC, 02230 100 0020
3.3	Site Survey	1	LS	$5,000	$5,000	[1]
3.4	Construct Equipment Decontamination Pad	1	LS	$7,500	$7,500	Means 2004 HC
3.5	Construct Soil Stockpiling Area	2	LS	$2,500	$5,000	Means 2004 HC
3.6	Install Erosion and Sedimentation Controls	3,000	LF	$3.73	$11,190	Means 2004 HC, 02370 700 1250
	Subtotal				**$34,990**	
4.0 Excavate and Stockpile Surficial Soils						
4.1	Excavate and Load Soil into Trucks	53,000	CY	$2.29	$121,370	Means 2004 ER, 17 03 0277
4.2	Haul Soil to Stockpile Area	63,600	CY	$5.50	$349,800	Means 2004 HC, 02315 490 1245
4.3	Dust Suppression (hourly passes over excavation area)	3,772	MSF	$1.31	$4,941	Means 2004 ER, 33 08 0585
4.4	Perimeter Air Samples (4 per work day)	353	EA	$25.00	$8,833	Aero-Tech, 2005
4.5	Cleanup Confirmation Samples (1 per 500 CY)	106	EA	$100.00	$10,600	[1]
4.6	Equipment Decontamination (for duration of excavation)	707	HR	$39.56	$27,956	Means 2004 ER, 33 17 0823
4.7	Stockpile Management	63,600	CY	$1.32	$83,952	Means 2004 HC, 02230 500 0100
	Subtotal				**$607,452**	
5.0 Treatment of Stockpiled Soil						
5.1	Mobilize/Assemble Treatment Unit	1	LS	$127,500	$127,500	Means 2004 ER, 33 12 0206
5.2	Site Preparation Charge	1	LS	$540,500	$540,500	Means 2004 ER, 33 12 0203
5.3	Startup Charge for Treatment Unit	1	LS	$44,800	$44,800	Means 2004 ER, 33 12 0209
5.4	Pre-Treatment Unit	1	EA	$127,500	$127,500	Means 2004 ER, 33 12 0224
5.5	Process Equipment Rental	4	MONTH	$765,446	$3,061,784	Means 2004 ER, 33 12 0215
5.6	Process Labor	4	MONTH	$68,400	$273,600	Means 2004 ER, 33 12 0218
5.7	Treatment System Operating Cost (per CY)	63,600	CY	$82	$5,215,200	EPA/540/R-94/513
5.8	Treatment System Consumables (per CY)	63,600	CY	$25	$1,590,000	Means 2004 ER, 33 12 0221
5.9	Off-Site Disposal Metal Sludges	5,000	TON	$328	$1,640,000	Boston Environmental, 2005
5.10	Decontaminate/Demobilize Treatment Unit	1	LS	$329,500	$329,500	Means 2004 ER, 33 12 0212
	Subtotal				**$12,950,384**	
6.0 Backfill and Site Restoration						
6.1	Load Treated Soil into Trucks	63,600	CY	$2.29	$145,644	Means 2004 ER, 17 03 0277
6.2	Transport Treated Soil to Backfill Site	63,600	CY	$4.70	$298,920	Means 2004 HC, 02315 490 0400
6.3	Spread Soil into Excavations	51,564	CY	$8.70	$448,606	Means 2004 HC, 02315 210 4060
6.4	Compact Fill in 6" Lifts	51,564	CY	$1.26	$64,971	Means 2004 HC, 02315 310 6210
6.5	Topsoil, Furnished and Placed (4")	925	CY	$26.95	$24,929	Means 2004 ER, 18 05 0301
6.6	Seeding	75,000	SF	$0.09	$6,750	Means 2004 ER, 18 05 0402
6.7	Asphalt Restoration	400,000	SF	$1.00	$400,000	Means 2004 HC, 02740 315 0020
6.8	Decon Pad Demo and Disposal	1	LS	$4,000.00	$4,000	[1]
6.9	Demob Support Facilities	1	LS	$5,000.00	$5,000	[1]
6.10	Restore Laydown and Stockpile Areas	1	LS	$20,000.00	$20,000	[1]
	Subtotal				**$1,418,819**	
TOTAL DIRECT COSTS					**$15,126,985**	

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TABLE SS-5
ALTERNATIVE SS-5 CAPITAL COSTS
EXCAVATION, TREATMENT, AND ON-SITE REUSE - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
7.0 Other Costs						
7.1	Project Management (5%)				$756,349	OSWER 9355.0-75
7.2	Engineering and Design (6%)				$907,619	OSWER 9355.0-75
7.3	Construction Management (6%)				$907,619	OSWER 9355.0-75
7.4	Location Adustment (10%)				$1,512,699	Means 2004 ER
7.5	Contingency (25%)				$3,781,746	OSWER 9355.0-75
TOTAL OTHER COSTS					**$7,866,032**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE SS-5					**$22,993,018**	

Notes:
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE SS-5-A
ALTERNATIVE SS-5 COST ASSUMPTIONS
EXCAVATION, TREATMENT, AND ON-SITE REUSE - MISHAWUM LAKE SURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
	CAPITAL COSTS (TABLE SS-5)	
General Assumptions		
	Alternative SS-5 features the excavation of all surface soil (0 to 3 feet below ground surface) that contains concentrations of arsenic that exceed the PRG (50 mg/kg). Excavated soil would be transported to an on-site staging area, treated using acid extraction, and transported back to the excavation site to be used as clean backfill material. The ground surface throughout the soil excavation area would be restored to its current condition (either vegetated or paved).	
	Since under this alternative there would be no contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, there would be no operations and maintenance costs associated with the alternative and five-year reviews would not be conducted.	
	Alternative SS-5 would also include a pre-design investigation (PDI) to more accurately delineate the extent of surface soil containing arsenic in excess of the surface soil PRG. Based on the existing data, the proposed excavation area for surface soil removal is approximately 475,000 SF. Building footprints were not included in the estimated contaminated soil area, and no excavation of soil beneath existing buildings was assumed for the development of this cost estimate. The wetland area located between SO-09 and the Halls Brook Holding Area was not included in the surface soil excavation area.	
1.0 Pre-Design Investigation		
	The pre-design investigation that would be performed under this alternative would be the same as was described for Alternative SS-2.	
	The assumptions and basis of cost estimates for the PDI are described on Table SS-2-A.	
2.0 Mobilization/Demobilization		
	Mobilization/demobilization costs for this alternative would be the same as was described for Alternative SS-4. The assumptions and basis of costs for mobilization/demobilization are described on Table SS-4-A. Mob/demob costs for the treatment unit are included in Section 5.0 of this cost estimate.	
3.0 Site Preparation		
	Site preparation costs for this alternative would be the same as was described for Alternative SS-4. The assumptions and basis of costs for site preparation are described on Table SS-4-A. Site prep costs for the treatment unit are included in Section 5.0 of this cost estimate.	
4.0 Excavate and Stockpile Surface Soils		
	The excavation and stockpiling of soil for this alternative would be the same as was described for Alternative SS-4. The assumptions and basis of costs for the tasks included in this section of the cost estimate are presented on Table SS-4-A.	
5.0 Transportation and Disposal of Raymark Waste		
5.1	Mobilize/Assemble Treatment Unit	Mobilize 18,000 CY/MONTH acid extraction treatment unit and assemble on site.
5.2	Site Preparation Charge	Prepare on-site area for treatment works, construct and assemble soil handling equipment, support areas, material staging areas. Mobilize tanks and other ancillary treatment equipment (screens, scrubbers, tanks, rinse/dewatering systems).
5.3	Startup Charge for Treatment Unit	Prepare soil treatment unit for use. Perform start-up checks and tests.
5.4	Pre-Treatment Unit	
5.5	Process Equipment Rental	Rental of treatment unit and ancillary treatment equipment required to accomplish soil treatment. Hourly rate = $1100.
5.6	Process Labor	Labor to operate treatment system includes 1 field superindendent/safety engineer and 4 equipment operators. Daily rate = $1500.
5.7	Treatment System Operating Cost	Treatment system operating cost based on rates developed for EPA/540/R-94/513 (*Acid Extraction Treatment System for Treatment of Metal Contaminated Soils*).
5.8	Treatment System Consumable Materials	
5.9	Off-Site Disposal Metal Sludges	Assume $328/TON for transportation and disposal of hazardous sludges developed during treatment processes.
5.10	Decontaminate/Demobilize Treatment Unit	Decontaminate and demobilize 18,000 CY/month treatment unit.
6.0 Backfill and Site Restoration		
6.1	Load Treated Soil into Trucks	Load treated soil into trucks using hydraulic excavator.
		Crew CODET: 1 laborer, 1 hydraulic excavator, 2.00 CY bucket, 1 equipment operator. Daily rate = $1,400.
		63,600 CY * 1 HR/75 CY ≈ 850 HR
6.2	Transport Treated Soil to Backfill Site	Transport using 12 CY dump trucks. 2 mile round trip assumed (2.6 loads/hour).
		Crew B-34B (4): 1 truck driver, 1 dump truck (16 ton). $850 daily rate.
		Assume four trucks cycling between locations to provide 600 CY/DAY capacity.
6.3	Spread Soil into Excavations	Front-end loader, wheel-mounted. Crew B-10S: FE loader, 1 equipment operator, 0.5 laborer. Daily rate = $850.
		51,564 CY * 1000 CY/day ≈ 52 days.
6.4	Compact Fill in 6" Lifts	Vibrating roller, 6" lifts, 3 passes. Crew B-10C: 1 vibratory loader, 1 dozer, 1 equipment operator, 0.5 laborer. Daily rate = $2200.
		Total time = 51,563 CY * 1735 CY/day ≈ 30 days.
6.5	Topsoil, Furnished and Placed (4")	Topsoil furnished and placed, 4" thick. 18 CY/HR.
		Crew CODLA: 1 equipment operator, 1 semi-skilled laborer. Daily rate = $650.
		925 CY * 1 HR/18 CY ≈ 50 HR.
6.6	Seeding	Vegetative cover using mechanical seeder, power mulcher, and watering truck.
		Power mulcher: 1 highway truck, 1 power mulcher, 1 laborer, 1 truck driver. Daily rate = $700.
		Mechanical seeding: 1.25 semi-skilled laborers. Daily rate = $250.
		Watering: 1 water truck, 1 truck driver, 2 laborers. Daily rate = $900.
6.7	Repave with Asphalt	Asphaltic concrete pavement, lots and driveways. 6" stone base, 2" binder course, 4" thick topping.
		Crew B-25C: 1 asphalt paver, 1 roller, 2 equipment operators, 1 labor foreman, 3 laborers. Daily rate = $4000.
		Total time = 400,000 SF / 10,800 SF/day ≈ 35 days.

TABLE SUB-2
ALTERNATIVE SUB-2 CAPITAL COSTS
MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SUBSURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0	**Pre-Design Investigation**					
1.1	Mobilization/Demobilization	1	LS	$1,000.00	$1,000	[1]
1.2	Sampling Equipment	1	LS	$2,500.00	$2,500	[1]
1.3	Sampling Labor (2 workers, 4 weeks, 50 HR/WK)	400	HR	$85.00	$34,000	[1]
1.4	Direct Push Borings - Geoprobe per day (10 borings/day)	20	DAY	$1,200.00	$24,000	TDS, 2005
1.5	Soil Sample Collection (3 samples/boring)	600	LF	$2.00	$1,200	TDS, 2005
1.6	Field XRF Analysis - Rental Charge	1	MONTH	$4,200.00	$4,200	Niton, 2005
1.7	Laboratory Analysis (20% for confirmation)	120	EA	$50.00	$6,000	[1]
1.8	IDW Transportation/Disposal (drums)	20	EA	$285.00	$5,700	[1]
1.9	Reporting	100	HR	$100.00	$10,000	[1]
	Subtotal				**$88,600**	
2.0	**Institutional Controls**					
2.1	Legal Fees, Deed Restrictions, Property Surveys	7	EA	$20,000	$140,000	[1]
	Subtotal				**$140,000**	
3.0	**Monitoring Well Construction**					
3.1	Mobilize Drill Rig and Crew	1	LS	$2,700.00	$2,700	Means 2004 ER, 33 01 0101
3.2	Drilling (Assume 15 Wells, 30 LF Avg Depth)	450	LF	$16.76	$7,542	Means 2004 ER, 33 02 0601
3.3	Install PVC Well Screens (2" diameter)	150	LF	$14.28	$2,142	Means 2004 ER, 33 23 0201
3.4	Install PVC Well Casing (2" diameter)	300	LF	$10.16	$3,048	Means 2004 ER, 33 23 0101
3.5	Install Filter Pack	180	LF	$10.65	$1,917	Means 2004 ER, 33 23 1401
3.6	Install Bentonite Seal	15	EA	$39.29	$589	Means 2004 ER, 33 23 2101
3.7	Install Annular Seal	30	LF	$47.40	$1,422	Means 2004 ER, 33 23 1801
3.8	PVC Well Plugs	15	EA	$19.12	$287	Means 2004 ER, 33 23 0301
3.9	Flush-Mount Protective Cover with Locking Cap	10	EA	$309.97	$3,100	Means 2004 ER, 33 23 2211
3.10	Above-Ground Protective Casing with Locking Cap	5	EA	$297.41	$1,487	Means 2004 ER, 33 23 2251
3.11	Surface Pad, Concrete 2' x 2'	15	EA	$115.30	$1,730	Means 2004 ER, 33 23 1504
3.12	Well Development (2 HR/WELL)	15	EA	$170.00	$2,550	[1]
3.13	IDW Transportation/Disposal (drums)	35	EA	$285.00	$9,975	[1]
	Subtotal				**$38,488**	
TOTAL DIRECT COSTS					**$267,088**	
4.0	**Other Costs**					
4.1	Project Management (8%)				$21,367	OSWER 9355.0-75
4.2	Contingency (10%)				$26,709	OSWER 9355.0-75
TOTAL OTHER COSTS					**$48,076**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE SUB-2					**$315,164**	

NOTES:

[1] Best estimate based on previous experience.

TABLE SUB-2-OM
ALTERNATIVE SUB-2 OPERATIONS AND MAINTENANCE COSTS
MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SUBSURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual Inspection Costs						
OM.1.1	Periodic Inspections (Quarterly)	40	HR	$100	$4,000	[1]
OM.1.2	Reporting (Quarterly)	4	EA	$5,000	$20,000	[1]
	Subtotal				**$24,000**	
OM.2.0 Groundwater Monitoring Costs (Years 1-10)						
OM.2.1	Sample Collection Labor (15 wells/event)	90	HR	$85	$7,650	[1]
OM.2.2	Sampling Equipment Rental	2	EA	$2,000	$4,000	[1]
OM.2.3	Groundwater Sample Analyses (18 samples/event)					
2.3.1	*Metals (Arsenic)*	36	EA	$125	$4,500	[1]
2.3.2	*VOCs*	36	EA	$200	$7,200	[1]
2.3.3	*SVOCs*	36	EA	$300	$10,800	[1]
OM.2.4	Data Validation	2	EA	$4,000	$8,000	[1]
OM.2.5	Reporting	2	EA	$10,000	$20,000	[1]
	Subtotal				**$62,150**	
TOTAL ANNUAL O&M COSTS (Years 1-10)					**$86,150**	
TOTAL ANNUAL O&M COSTS (Years 11-30)					**$24,000**	
OM.3.0a Other O&M Costs (Years 1-10)						
OM.3.1a	Project Management (10%)				$8,615	OSWER 9355.0-75
OM.3.2a	O&M Contingency (15%)				$12,923	OSWER 9355.0-75
	Subtotal				**$21,538**	
OM.3.0b Other O&M Costs (Years 11-30)						
OM.3.1b	Project Management (10%)				$2,400	OSWER 9355.0-75
OM.3.2b	O&M Contingency (15%)				$3,600	OSWER 9355.0-75
	Subtotal				**$6,000**	
ANNUAL O&M COSTS ALTERNATIVE SUB-2 (YEARS 1-10					**$107,688**	
ANNUAL O&M COSTS ALTERNATIVE SUB-2 (YEARS 11-30					**$30,000**	

Notes:

[1] Best estimate based on previous experience.

Present worth analysis includes periodic cost of $20,000 to conduct five-year reviews.

TABLE SUB-2-PW
ALTERNATIVE SUB-2 PRESENT WORTH ANALYSIS
MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SUBSURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$315,164	0	$0	$315,164	7.0%	1.000	$315,164
1	$0	$107,688	$0	$107,688	7.0%	0.935	$100,643
2	$0	$107,688	$0	$107,688	7.0%	0.873	$94,058
3	$0	$107,688	$0	$107,688	7.0%	0.816	$87,905
4	$0	$107,688	$0	$107,688	7.0%	0.763	$82,154
5	$0	$107,688	$20,000	$127,688	7.0%	0.713	$91,039
6	$0	$107,688	$0	$107,688	7.0%	0.666	$71,757
7	$0	$107,688	$0	$107,688	7.0%	0.623	$67,062
8	$0	$107,688	$0	$107,688	7.0%	0.582	$62,675
9	$0	$107,688	$0	$107,688	7.0%	0.544	$58,575
10	$0	$107,688	$20,000	$127,688	7.0%	0.508	$64,910
11	$0	$30,000	$0	$30,000	7.0%	0.475	$14,253
12	$0	$30,000	$0	$30,000	7.0%	0.444	$13,320
13	$0	$30,000	$0	$30,000	7.0%	0.415	$12,449
14	$0	$30,000	$0	$30,000	7.0%	0.388	$11,635
15	$0	$30,000	$20,000	$50,000	7.0%	0.362	$18,122
16	$0	$30,000	$0	$30,000	7.0%	0.339	$10,162
17	$0	$30,000	$0	$30,000	7.0%	0.317	$9,497
18	$0	$30,000	$0	$30,000	7.0%	0.296	$8,876
19	$0	$30,000	$0	$30,000	7.0%	0.277	$8,295
20	$0	$30,000	$20,000	$50,000	7.0%	0.258	$12,921
21	$0	$30,000	$0	$30,000	7.0%	0.242	$7,245
22	$0	$30,000	$0	$30,000	7.0%	0.226	$6,771
23	$0	$30,000	$0	$30,000	7.0%	0.211	$6,328
24	$0	$30,000	$0	$30,000	7.0%	0.197	$5,914
25	$0	$30,000	$20,000	$50,000	7.0%	0.184	$9,212
26	$0	$30,000	$0	$30,000	7.0%	0.172	$5,166
27	$0	$30,000	$0	$30,000	7.0%	0.161	$4,828
28	$0	$30,000	$0	$30,000	7.0%	0.150	$4,512
29	$0	$30,000	$0	$30,000	7.0%	0.141	$4,217
30	$0	$30,000	$20,000	$50,000	7.0%	0.131	$6,568
TOTAL	**$315,164**	**$1,676,875**	**$120,000**	**$2,112,039**			**$1,276,236**

TABLE SUB-2-A
ALTERNATIVE SUB-2 COST ASSUMPTIONS
MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SUBSURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
	CAPITAL COSTS (TABLE SUB-2)	
General Assumptions		
	Alternative SUB-2 involves the imposition of institutional controls on each of the properties that are located within the contaminated subsurface soil are that is depicted on Figure 2-3b of the FS. For the purposes of estimating cost for the FS, it was assumed that seven properties would be impacted by this alternative. A pre-design investigation (PDI) would be performed to more accurately delineate the extent of surface soil containing arsenic in excess of the surface soil PRG (50 mg/kg). Based on data that is collected during the PDI, additional properties may be subject to institutional controls in order to provide adequate protection to human health from risks associated with arsenic in soil.	
1.0 Pre-Design Investigation		
	For the purpose of estimating costs for the FS, the Pre-Design Investigation that would be performed under this alternative was assumed to consist of the advancement of approximately 100 direct-push technology (DPT) soil borings throughout the Mishawum Lake bed to determine the lateral extent of subsurface soil containing arsenic in excess of its PRG (50 mg/kg).	
	Each soil boring was assumed to extend fifteen feet below ground surface, for a total drilling quantity of 1,500 LF. The rate of soil boring advancement (including soil sample collection, sample processing, sample analysis, and sample shipping) was assumed to be 5 soil borings per day, which translates to 20 days (4 weeks) to perform the investigation. Three soil samples would be collected from each soil boring for field analysis using an XRF unit. 20% of the soil samples that are analyzed in the field will also be preserved, packaged, and shipped an off-site laboratory for analysis. The cost estimates presented in this section are based on these general assumptions.	
1.1	Mobilization/Demobilization	Assumes mob/demob of drilling rig, sampling equipment/supplies, and all labor required to perform investigation. Less than 50 mile mob/demob distance assumed.
1.2	Sampling Equipment	Sampling equipment includes weekly rental or purchase of the following items: pickup truck/van, photoionization detector, sampling tools, sample containers, and decontamination equipment/supplies. Shipping and handling of XRF unit included.
1.3	Sampling Labor	Sampling labor estimate assumes two samplers working two weeks (10 days) at 50 hours/week. Total = 200 hours.
1.4	Direct Push Borings	GeoProbe per day cost estimate based on vendor quote for similar project.
1.5	Soil Sample Collection	Soil sample collection cost estamate based on vendor quote for similar project.
1.6	Field XRF Analysis - Rental Charge	Monthly rental of Xli 702 model x-ray fluorescence unit at $4,200 based on quote from Niton Corporation.
1.7	Laboratory Analysis	Assume 20 percent of field samples would be preserved and shipped to a fixed lab for confirmatory analysis.
1.8	IDW Transportation/Disposal	Assume 100 four-inch soil borings with 15-foot depth would create approximately 1000 gallons of soil IDW, which would require off-site transportation/disposal of twenty 55-gallon drums. $285/drum based on previous experience with similar projects.
1.9	Reporting	Assume 100 hours for report preparation to document the findings of the PDI.
2.0 Institutional Controls		
2.1	Legal Fees, Deed Restrictions, Property Surveys	Legal fees associated with drafting and implementing deed restrictions, costs to perform property surveys at $20,000 per property.
3.0 Monitoring Well Construction		
	Alternative SUB-2 would involve the implementation of a groundwater monitoring program to evaluate groundwater conditions upgradient and within the subsurface soil risk area to verify that arsenic contamination in soils does not create risks in the future. The monitoring program would consist of the semi-annual collection of groundwater samples from 15 monitoring wells located within the subsurface soil risk area. For the purposes of estimating costs for the FS it was assumed that the monitoring program would be re-evaluated after ten years and discontinued.	
	The assumptions and basis of costs to construct groundwater monitoring wells within the subsurface soil risk area are presented on Table GW-2-A under the assumptions for Alternative GW-2.	
	OPERATIONS AND MAINTENANCE COSTS (TABLE SUB-2-OM)	
OM.1.0 Annual Inspection Costs		
OM.1.1	Periodic Inspections (Quarterly)	Assume 10 hours per quarter for inspections to verify the effectiveness of institutional controls at preventing exposure to subsurface soils in the former Mishawum Lake bed.
OM.1.2	Inspection Reports (Quarterly)	Assume $5000 per quarter for the preparation of inspection reports to document quarterly inspection activities and findings.
OM.2.0 Groundwater Monitoring Costs		
OM.2.1	Sample Collection Labor	Assume labor for collection of samples from 15 wells at 3 HR/WELL = 45 HR. Assume 15 hours per sampling event for sample processing, paperwork, and shipping. 60 hours per sampling event * 4 events/year = 240 hours per year.
OM.2.2	Sampling Equipment Rental	$2000 per event for 2 week rental of groundwater pumps, multiparameter water quality meters, turbidity meters, water level measurement probes, field vehicle.
OM.2.3	Groundwater Sample Analyses	Assume each groundwater sample analyzed for metals, VOCs, and SVOCs. Quality control samples include 1 field duplicate, 1 equipment blank, and 1 trip blank.
OM.2.4	Data Validation	Assume 40 HRS (approximately 1 HR per sample) for data validation at $100/HR.
OM.2.5	Reporting	Assume $10,000 per quarter for preparation of data summary reports.

TABLE SUB-3
ALTERNATIVE SUB-3 CAPITAL COSTS
PERMEABLE COVER AND MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SUBSURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0	**Pre-Design Investigation**					
1.1	Mobilization/Demobilization	1	LS	$1,000.00	$1,000	[1]
1.2	Sampling Equipment	1	LS	$2,500.00	$2,500	[1]
1.3	Sampling Labor (2 workers, 4 weeks, 50 HR/WK)	400	HR	$85.00	$34,000	[1]
1.4	Direct Push Borings - Geoprobe per day (10 borings/day)	20	DAY	$1,200.00	$24,000	TDS, 2005
1.5	Soil Sample Collection (3 samples/boring)	600	LF	$2.00	$1,200	TDS, 2005
1.6	Field XRF Analysis - Rental Charge	1	MONTH	$4,200.00	$4,200	Niton, 2005
1.7	Laboratory Analysis (20% for confirmation)	120	EA	$50.00	$6,000	[1]
1.8	IDW Transportation/Disposal	8	DRUM	$285.00	$2,280	[1]
1.9	Reporting	100	HR	$100.00	$10,000	[1]
	Subtotal				**$85,180**	
2.0	**Institutional Controls**					
2.1	Legal Fees, Deed Restrictions, Property Surveys	7	EA	$20,000	$140,000	[1]
	Subtotal				**$140,000**	
3.0	**Mobilization/Demobilization**					
3.1	Equipment Mobilization	1	LS	$20,000	$20,000	[1]
3.2	Field Support Facilities	1	LS	$4,000	$4,000	[1]
3.3	Monthly Costs associated with Field Support	8	MONTH	$3,000	$24,000	[1]
	Subtotal				**$48,000**	
4.0	**Site Preparation**					
4.1	Site Access Road Construction	500	SY	$12.55	$6,275	Means 2004 HC, 02720 200 0300
4.2	Clear and Grub	6	ACRE	$3,150	$18,900	Means 2004 HC, 02230 100 0020
4.3	Site Survey	1	LS	$5,000	$5,000	[1]
4.4	Construct Equipment Decontamination Pad	2	LS	$7,500	$15,000	Means 2004 HC
4.5	Construct Soil Stockpiling Area	2	LS	$3,000	$6,000	Means 2004 HC
4.6	Install Erosion and Sedimentation Controls	4,000	LF	$3.73	$14,920	Means 2004 HC, 02370 700 1250
	Subtotal				**$66,095**	
5.0	**Excavate and Stockpile Surficial Soils**					
5.1	Excavate and Load Soil into Trucks	28,000	CY	$2.29	$64,120	Means 2004 ER, 17 03 0277
5.2	Haul Soil to Stockpile Area	33,600	CY	$5.50	$184,800	Means 2004 HC, 02315 490 1245
5.3	Dust Suppression (hourly passes over excavation area)	3,995	MSF	$1.31	$5,233	Means 2004 ER, 33 08 0585
5.4	Perimeter Air Samples (4 per work day)	187	EA	$25.00	$4,667	Aero-Tech, 2005
5.5	Equipment Decontamination (for duration of excavation)	373	HR	$39.56	$14,769	Means 2004 ER, 33 17 0823
5.6	Stockpile Management	33,600	CY	$1.32	$44,352	Means 2004 HC, 02230 500 0100
	Subtotal				**$317,941**	
6.0	**Transportation and Off-Site Disposal of Soil**					
6.1	Load Contaminated Soil into Trucks	6,600	CY	$2.29	$15,114	Means 2004 ER, 17 03 0277
6.2	Load Uncontaminated Soil into Trucks	27,000	CY	$2.29	$61,830	Means 2004 ER, 17 03 0277
6.3	Equipment Decontamination	448	HR	$39.56	$17,723	Means 2004 ER, 33 17 0823
6.4	Transportation of Contaminated Soil	9,900	TON	$89.00	$881,100	Boston Environmental, 2005
6.5	Off-Site Disposal of Soil	9,900	TON	$239.00	$2,366,100	Boston Environmental, 2005
	Subtotal				**$3,341,867**	
7.0	**Construction of Permeable Cover**					
7.1	Place Geotextile	500,000	SF	$0.25	$126,111	Means 2004 HC, 02340 300 1500
7.2	Backfill with Stockpiled Material	27,000	CY	$4.79	$129,330	Means 2004 ER, 17 03 0430
7.3	Topsoil, Furnished and Placed (6")	6,167	CY	$26.95	$166,192	Means 2004 ER, 18 05 0301
7.4	Seeding	11.5	ACRE	$3,611.00	$41,449	Means 2004 ER, 18 05 0402
7.5	Minor Repairs to Existing Asphalt	10,000	SF	$1.17	$11,700	Means 2004 HC, 02740 315 1100
	Subtotal				**$463,081**	
8.0	**Site Restoration**					
8.1	Decon Pad Demo and Disposal	1	LS	$2,000.00	$2,000	[1]
8.2	Demob Support Facilities	1	LS	$2,500.00	$2,500	[1]
8.3	Restore Laydown and Stockpile Areas	1	LS	$5,000.00	$5,000	[1]
	Subtotal				**$9,500**	

TABLE SUB-3
ALTERNATIVE SUB-3 CAPITAL COSTS
PERMEABLE COVER AND MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SUBSURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
9.0	**Monitoring Well Construction**					
9.1	Mobilize Drill Rig and Crew	1	LS	$2,700.00	$2,700	Means 2004 ER, 33 01 0101
9.2	Drilling (Assume 15 Wells, 30 LF Avg Depth)	450	LF	$16.76	$7,542	Means 2004 ER, 33 02 0601
9.3	Install PVC Well Screens (2" diameter)	150	LF	$14.28	$2,142	Means 2004 ER, 33 23 0201
9.4	Install PVC Well Casing (2" diameter)	300	LF	$10.16	$3,048	Means 2004 ER, 33 23 0101
9.5	Install Filter Pack	180	LF	$10.65	$1,917	Means 2004 ER, 33 23 1401
9.6	Install Bentonite Seal	15	EA	$39.29	$589	Means 2004 ER, 33 23 2101
9.7	Install Annular Seal	30	LF	$47.40	$1,422	Means 2004 ER, 33 23 1801
9.8	PVC Well Plugs	15	EA	$19.12	$287	Means 2004 ER, 33 23 0301
9.9	Flush-Mount Protective Cover with Locking Cap	10	EA	$309.97	$3,100	Means 2004 ER, 33 23 2211
9.10	Above-Ground Protective Casing with Locking Cap	5	EA	$297.41	$1,487	Means 2004 ER, 33 23 2251
9.11	Surface Pad, Concrete 2' x 2'	15	EA	$115.30	$1,730	Means 2004 ER, 33 23 1504
9.12	Well Development (2 HR/WELL)	15	EA	$170.00	$2,550	[1]
9.13	IDW Transportation/Disposal (drums)	35	EA	$285.00	$9,975	[1]
	Subtotal				**$38,488**	
TOTAL DIRECT COSTS					**$4,510,152**	
9.0	**Other Costs**					
9.1	Project Management (5%)				$225,508	OSWER 9355.0-75
9.2	Engineering and Design (8%)				$360,812	OSWER 9355.0-75
9.3	Construction Management (6%)				$270,609	OSWER 9355.0-75
9.4	Location Adustment (10%)				$451,015	Means 2004 ER
9.5	Contingency (15%)				$676,523	OSWER 9355.0-75
TOTAL OTHER COSTS					**$1,984,467**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE SUB-3					**$6,494,619**	

Notes:
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE SUB-3-OM
ALTERNATIVE SUB-3 OPERATIONS AND MAINTENANCE COSTS
PERMEABLE COVER AND MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SUBSURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0	**Annual Inspection Costs**					
OM.1.1	Labor - Periodic Inspections (Quarterly)	40	HR	$100	$4,000	[1]
OM.1.2	Cap Maintenance (Assume 10% cap area per year)					
1.2.1	Topsoil, Furnished and Placed	617	CY	$26.95	$16,619	Means 2004 ER, 18 05 0301
1.2.2	Seeding	50,000	SF	$0.09	$4,500	Means 2004 ER, 18 05 0402
1.2.3	Maintenance Labor	64	HR	$75.00	$4,800	[1]
OM.1.3	Asphalt Maintenance	4,300	SF	$1.17	$5,031	Means 2004 HC, 02740 315 1100
OM.1.4	Reporting (Annual)	4	EA	$7,500.00	$30,000	[1]
	Subtotal				**$64,950**	
OM.2.0	**Groundwater Monitoring Costs (Years 1-10)**					
OM.2.1	Sample Collection Labor (15 wells/event)	90	HR	$85	$7,650	[1]
OM.2.2	Sampling Equipment Rental	2	EA	$2,000	$4,000	[1]
OM.2.3	Groundwater Sample Analyses (18 samples/event)					
2.3.1	*Metals (Arsenic)*	36	EA	$125	$4,500	[1]
2.3.2	*VOCs*	36	EA	$200	$7,200	[1]
2.3.3	*SVOCs*	36	EA	$300	$10,800	[1]
OM.2.4	Data Validation	2	EA	$4,000	$8,000	[1]
OM.2.5	Reporting	2	EA	$10,000	$20,000	[1]
	Subtotal				**$62,150**	
TOTAL ANNUAL O&M COSTS (Years 1-10)					**$127,100**	
TOTAL ANNUAL O&M COSTS (Years 11-30)					**$64,950**	
OM.3.0a	**Other O&M Costs (Years 1-10)**					
OM.3.1a	Project Management (10%)				$12,710	OSWER 9355.0-75
OM.3.2a	O&M Contingency (15%)				$19,065	OSWER 9355.0-75
	Subtotal				**$31,775**	
OM.3.0b	**Other O&M Costs (Years 11-30)**					
OM.3.1b	Project Management (10%)				$6,495	OSWER 9355.0-75
OM.3.2b	O&M Contingency (15%)				$9,743	OSWER 9355.0-75
	Subtotal				**$16,238**	
ANNUAL O&M COSTS ALTERNATIVE SUB-3 (YEARS					**$158,875**	
ANNUAL O&M COSTS ALTERNATIVE SUB-3 (YEARS 11-30)					**$81,188**	

Notes:

Present worth analysis assumes $30,000 every five years for preparation of five-year review report.

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.

Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.

[1] Best estimate based on previous experience.

TABLE SUB-3-PW
ALTERNATIVE SUB-3 PRESENT WORTH ANALYSIS
PERMEABLE COVER AND MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SUBSURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$6,494,619	0	$0	$6,494,619	7.0%	1.000	$6,494,619
1	$0	$158,875	$0	$158,875	7.0%	0.935	$148,482
2	$0	$158,875	$0	$158,875	7.0%	0.873	$138,768
3	$0	$158,875	$0	$158,875	7.0%	0.816	$129,689
4	$0	$158,875	$0	$158,875	7.0%	0.763	$121,205
5	$0	$158,875	$30,000	$188,875	7.0%	0.713	$134,665
6	$0	$158,875	$0	$158,875	7.0%	0.666	$105,865
7	$0	$158,875	$0	$158,875	7.0%	0.623	$98,939
8	$0	$158,875	$0	$158,875	7.0%	0.582	$92,467
9	$0	$158,875	$0	$81,188	7.0%	0.544	$44,161
10	$0	$158,875	$30,000	$188,875	7.0%	0.508	$96,015
11	$0	$81,188	$0	$81,188	7.0%	0.475	$38,572
12	$0	$81,188	$0	$81,188	7.0%	0.444	$36,048
13	$0	$81,188	$0	$81,188	7.0%	0.415	$33,690
14	$0	$81,188	$0	$81,188	7.0%	0.388	$31,486
15	$0	$81,188	$30,000	$111,188	7.0%	0.362	$40,300
16	$0	$81,188	$0	$81,188	7.0%	0.339	$27,501
17	$0	$81,188	$0	$81,188	7.0%	0.317	$25,702
18	$0	$81,188	$0	$81,188	7.0%	0.296	$24,021
19	$0	$81,188	$0	$81,188	7.0%	0.277	$22,449
20	$0	$81,188	$30,000	$111,188	7.0%	0.258	$28,733
21	$0	$81,188	$0	$81,188	7.0%	0.242	$19,608
22	$0	$81,188	$0	$81,188	7.0%	0.226	$18,325
23	$0	$81,188	$0	$81,188	7.0%	0.211	$17,126
24	$0	$81,188	$0	$81,188	7.0%	0.197	$16,006
25	$0	$81,188	$30,000	$111,188	7.0%	0.184	$20,486
26	$0	$81,188	$0	$81,188	7.0%	0.172	$13,980
27	$0	$81,188	$0	$81,188	7.0%	0.161	$13,066
28	$0	$81,188	$0	$81,188	7.0%	0.150	$12,211
29	$0	$81,188	$0	$81,188	7.0%	0.141	$11,412
30	$0	$81,188	$30,000	$111,188	7.0%	0.131	$14,606
TOTAL	**$6,494,619**	**$3,212,506**	**$180,000**	**$9,809,438**			**$8,070,203**

TABLE SUB-3-A
ALTERNATIVE SUB-3 COST ASSUMPTIONS
PERMEABLE COVER AND MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SUBSURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
	CAPITAL COSTS (TABLE SUB-3)	
General Assumptions		
	Alternative SUB-3 is a containment alternative that involves the construction of a permeable cover over contaminated subsurface soil areas that are currently vegetated at the surface and therefore potentially accessible to human receptors. The existing asphalt surfaces that currently occupy much of th former Mishawum Lake bed would be left in place (or improved, if necessary) so that underlying contaminated soil remains contained beneath the asphalt surface.	
	Construction of the permeable cover would involve the excavation of approximately 18 inches of contaminated soil from the vegetated areas of arsenic-contaminated subsurface soil identified on Table 2-3b of the FS (approximately 500,000 square feet). This soil would be stockpiled on site, characterized, and transported for disposal at an EPA-approved off-site facility. The permeable cover would consist of a geotextile overlain by 12 inches of clean gravel and 6 inches of topsoil that would be planted with grass.	
	Alternative SUB-3 would also involve the imposition of institutional controls on each of the properties that are located within the contaminated subsurface soil area (Figure 2-3b), designed to restrict or prevent activities that might enable future exposures to contaminated subsurface soil at the site. For the purposes of estimating cost for the FS, it was assumed that seven properties would be impacted by this alternative. A pre-design investigation (PDI) woul be performed to more accurately delineate the extent of surface soil containing arsenic in excess of the surface soil PRG (50 mg/kg). Based on data that is collected during the PDI, additional properties may be subject to institutional controls in order to provide adequate protection to human health from risks associated with arsenic in soil.	
1.0 Pre-Design Investigation		
	The pre-design investigation that would be performed under this alternative would be the same as was described for Alternative SUB-2.	
	The assumptions and basis of cost estimates for the PDI are described on Table SUB-2-A.	
2.0 Institutional Controls		
2.1	Legal Fees, Deed Restrictions, Property Surveys	Legal fees associated with drafting and implementing deed restrictions, costs to perform property surveys at $20,000 per property.
3.0 Mobilization/Demobilization		
	One work week (5 days) assumed for mobilization of labor and equipment for this alternative.	
3.1	Equipment/Labor Mobilization/Demobilization	Assume less than 50 mile haul distance for all equipment.
		Equipment would be mobilized and demobilized to and from the site once for this project.
3.2	Field Support Facilities	Field support facilities will be mobilized and demobilized to and from the central field support area once during the course of the project.
		The following items are included in this cost line item: office trailer @ $500, storage trailer @ $500, dumpster @ $100, sanitary facilities @ $100, soil sampling equipment @ $2000.
3.3	Monthly Costs associated with Field Support	Includes monthly rental costs for duration of project for the following: office trailer @ $400, storage trailer @ $200, utilities @ $200, dumpster @ $200, sampling materials @ $1000, air sampling equipment (PID) @ 750.
		Duration of project = Mobilization (1 week) + Site Prep (1 week) + Excavate and Stockpile (9 week) + Transportation and Disposal (3 week - overlap with excavation) + Cover Construction (11 week - overlap with excavation) + Site Restoration (1 week). 26 WEEKS≈ 8 MONTHS.
4.0 Site Preparation		
4.1	Site Access Road Construction	Assume approximately 300 LF x 15 LF wide gravel access road construction in northern portion of permeable cover construction area.
		300 LF * 15 LF = 4,500 SF = 500 SY.
4.2	Clear and Grub	Assume 6 acres clear and grub prior to excavation and cover placement.
		Cut and chip light trees to 6". Crew B-7: 1 labor foreman, 4 laborers, 1 chipping machine, 1 equipment operator, 1 FE loader. Daily rate = $3200.
		6 acres * 1 day/acre = 6 days.
4.3	Site Survey	Assume $5,000 for site survey to identify sampling locations/construction areas.
4.4	Construct Decontamination Pad	Decontamination pad as described for Alternative SS-3 (Table SS-3-A).
4.5	Construct Soil Stockpiling Area	Soil stockpiling area as described for Alternative SS-3 (Table SS-3-A).
4.4	Install Erosion and Sedimentation Controls	Erosion and sedimentation controls as described for Alternative SS-3 (Table SS-3-A).
5.0 Excavate and Stockpile Surficial Soils		
	Under this alternative, 1.5 feet of soil would be excavated from each of the contaminated subsurface soil areas and replaced with a geotextile and 1.5 feet of clean soil. This section presents estimated costs for the excavation of surficial soil, transportation of soil to the soil stockpiling area, and management of the stockpile. Other excavation support items and engineering controls (such as dust control, air sampling, and equipment decontamination) are also included.	
	Excavation and loading of soil from each of the contaminated soil areas (Figure 2-3b) would be accomplished using a hydraulic excavator. Excavated Raymark waste would be loaded directly into 10 CY dump trucks and transported to the soil stockpiling area.	
5.1	Excavate and Load Soil into Trucks	Excavate and Load, 2 CY Hydraulic Excavator, Medium Material, 75 CY/HR.
		Crew CODET: 1 laborer, 1 hydraulic excavator, 2.00 CY bucket, 1 equipment operator. Daily rate = $1,400.
		500,000 SF * 1.5 LF / 27 CF/CY ≈ 28,000 CY.
		28,000 CY * 1 HR/75 CY ≈ 370 HR.

TABLE SUB-3-A
ALTERNATIVE SUB-3 COST ASSUMPTIONS
PERMEABLE COVER AND MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SUBSURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
5.2	Haul Waste to Stockpile Area	12 CY dump trucks, 0.5-mile round trip, 3.2 loads/hour, 250 CY/ truck/day assumed. Assume two trucks transporting soil (6.4 loads/hour) to provide capacity for 75 CY/HR excavation rate.
		Crew B-34B (2): 1 truck driver, 1 dump truck (16 ton). $850 daily rate.
		Assume bulking factor from removal of soil at 1.2. Therefore 28,000 CY soil in-situ roughly equivalent to 33,600 CY of excavated soil that will be hauled to stockpiling/staging areas.
5.3	Dust Suppression	Dust suppression assumed to occur during excavation of soil to prevent airborne migration of contaminants via fugitive dusts and particulates.
		Crew COFWI: 1 water truck w/ 3,000 gallon water tank, 1 truck driver, 1 equipment operator, 1 submersible pump (6" diameter, 1950 GPM). Daily rate = $900.
		75 CY/HR * 8 HR/DAY = 600 CY/DAY assumed excavation volume. 600 CY≈ 16,000 CF. Assume depth of excavation 1.5 feet, therefore daily excavation area≈ 16,000 CF / 1.5 LF ≈ 10,700 SF. Assume hourly passes (8 per day) for 85,600 SF/DAY or 85.6 MSF/DAY.
5.4	Perimeter Air Samples	Monitoring of site perimeter for particulates to verify effectiveness of engineering controls to prevent the spread of airborne contamination.
		Assume 4 samples per day (one at north, south, east, and west borders of work area) analyzed for arsenic (metals) at $25/SAMPLE.
5.5	Equipment Decontamination	Assume decontamination of heavy vehicles as they leave excavation area to transport excavated soil. Operate 1,800 PSI pressure washer at $39.56/HR. Includes water, soap, electricity, and labor. Assume operation during entire duration of excavation activities.
5.6	Stockpile Management	Stockpile management assumed to include stripping & stockpiling of soil at each of the stockpiling areas. Assume 200 HP dozer adverse conditions, 1150 CY/day.
		Crew B-10B: 1 equipment operator, 0.5 laborer, 1 dozer. Daily rate = $1,500.
		Stockpile management would continue for duration of the project, therefore management of approximately 33,600 CY is assumed.
6.0	**Transportation and Off-Site Disposal of Soil**	
6.1	Load Contaminated Soil into Trucks	Excavate and Load, 2 CY Hydraulic Excavator, Medium Material, 75 CY/Hour. Load waste from stockpiles into 20 CY dump trailers for transportation to disposal facility.
		Crew CODET: 1 laborer (semi-skilled), 1 hydraulic excavator, crawler, 2.00 CY Bucket, 1 equipment operator. Daily rate = $1,400.
		6,600 CY of surface soil (≈ 100,000 SF) assumed to be contaminated based on quantities developed for Alternatives SS-4/SS-5 (see Figure 2-3a). [100,000 SF * 1.5 LF * 1.2] / 27 CF/CY.
		6,600 CY * 1 HR/75 CY ≈ 88 HR.
6.2	Load Uncontaminated Soil into Trucks	Assume surface soil located outside of the contaminated area depicted on Figure 2-3a to be uncontaminated. Total area of cover for this alternative≈ 500,000 SF. 400,000 SF of this surface soil assumed to be uncontaminated and fit for reuse as cover material.
		400,000 SF * 1.5 LF * 1.2 / 27 CF/CY ≈ 27,000 CY.
		27,000 CY * 75 CY/HR ≈ 360 HR.
6.3	Equipment Decontamination	Assume decontamination of heavy vehicles as they leave excavation area to transport excavated soil. Operate 1,800 PSI pressure washer at $39.56/HR. Includes water, soap, electricity, and labor. Assume operation during entire duration of excavation activities.
6.4	Transportation of Contaminated Soil	Assume transportation of excavated Raymark waste using 20 CY dump trailers. Unit cost for transportation based on quote from disposal subcontractor.
		1.5 tons per 1.0 cubic yards assumed for transportation and disposal estimates.
6.5	Off-Site Disposal of Soil	Assume disposal of waste at hazardous waste facility. Disposal cost includes full TCLP analysis (one per 500 tons of waste).
7.0	**Construction of Permeable Cover**	
	The permeable cover would consist of a geotextile fabric overlain by 12 inches of clean soil and 6 inches of topsoil. Uncontaminated soil that is excavated and stockpiled from the contaminated subsurface soil area but not located within the contaminated surface soil area (27,000 CY) would be used as clean material for construction of the cover.	
7.1	Place Geotextile	Place woven geotextile fabric, 2500 SY/DAY. 500,000 SF≈ 56,000 SY.
		56,000 SY / 2500 SY/day ≈ 22 days.
7.2	Backfill with Stockpiled Material	Gravel placed in 6" lifts, includes spreading and compaction. Also includes the following: soil density test nuclear method ASTM D2922-71, compaction water price $0.005/Gallon.
		Spread Fill with dozer: 1 equipment operator, 1 labor foreman. Daily rate = $1250
		Compaction: 1 compactor, 3 semi-skilled laborers. Daily rate = $700.
		Compaction Water: 1 water truck, 1 truck driver, 1 submersible pump, 1 equipment operator. Daily rate = $800.
		Soil Density Tests: 2 skilled workers. Daily rate = $900
		27,000 CY * 1 HR/100 CY ≈ 270 HR.

TABLE SUB-3-A
ALTERNATIVE SUB-3 COST ASSUMPTIONS
PERMEABLE COVER AND MONITORING WITH INSTITUTIONAL CONTROLS - MISHAWUM LAKE SUBSURFACE SOILS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
7.3	Topsoil, Furnished and Placed	Topsoil furnished and placed, 6" thick. 11.5 CY/HR
		Crew CODLA: 1 equipment operator, 1 semi-skilled laborer. Daily rate = $650
		6,167 CY * 1 HR/11.5 CY ≈ 540 HR.
7.4	Seeding	Vegetative cover using mechanical seeder, power mulcher, and watering truck.
		Power mulcher: 1 highway truck, 1 power mulcher, 1 laborer, 1 truck driver. Daily rate = $700.
		Mechanical seeding: 1.25 semi-skilled laborers. Daily rate = $250.
		Watering: 1 water truck, 1 truck driver, 2 laborers. Daily rate = $900.
7.5	Minor Repairs to Existing Asphalt	Assume 10,000 SF required. Hot mix, fill holes, 4" thick.
		Crew B-16: 1 dump truck, 1 truck driver, 2 laborers, 1 labor foreman. Daily rate = $1,850.
8.0 Site Restoration		
Site restoration activities would include demolition and disposal of materials from the decontamination pad, demobilization of support facilities, and restoration of stockpiling and equipment laydown areas.		
8.1	Decon Pad Demo and Disposal	Demolish and dispose of decontamination pad materials. $2000 estimate based on experience with similar projects.
8.2	Demob Support Facilities	$2500 estimate based on experience with similar projects.
8.3	Restore Laydown and Stockpile Areas	Demolish and dispose of materials. Cost estimate based on previous experience.
9.0 Monitoring Well Construction		
Alternative SUB-3 would involve the implementation of a groundwater monitoring program to evaluate groundwater conditions upgradient and within the subsurface soil risk area to verify that arsenic contamination in soils does not create risks in the future. The monitoring program would consist of the semi-annual collection of groundwater samples from 15 monitoring wells located within the subsurface soil risk area. For the purposes of estimating costs for the FS, it was assumed that the monitoring program would be re-evaluated after ten years and discontinued.		
The assumptions and basis of costs to construct groundwater monitoring wells within the subsurface soil risk area are presented on Table GW-2-A under the assumptions for Alternative GW-2.		
	OPERATIONS AND MAINTENANCE COSTS (TABLE SUB-3-OM)	
OM.1.0 Annual Inspection Costs		
OM.1.1	Periodic Inspections (Quarterly)	Assume 10 hours per quarter for inspections to verify the integrity of the cover and the effectiveness of institutional controls at preventing exposure to surface soils.
OM.1.2	Cap Maintenance	Assumes 10% of cover would need maintenance per year
	Topsoil, Furnished and Placed	6,167 CY * 0.1 = 617 CY.
	Seeding	500,000 SF * 0.1 = 50,000 SF.
OM.1.3	Asphalt Maintenance	Assume repairs of existing asphalt at approximately 1% of asphalt area
OM.1.4	Reporting (Quarterly)	Assume $7500 per quarter for the preparation of inspection reports to document quarterly inspection activities and findings.
OM.2.0 Groundwater Monitoring Costs		
OM.2.1	Sample Collection Labor	Assume labor for collection of samples from 15 wells at 3 HR/WELL = 45 HR. Assume 15 hours per sampling event for sample processing, paperwork, and shipping. 60 hours per sampling event * 4 events/year = 240 hours per year.
OM.2.2	Sampling Equipment Rental	$2000 per event for 2 week rental of groundwater pumps, multiparameter water quality meters, turbidity meters, water level measurement probes, field vehicle.
OM.2.3	Groundwater Sample Analyses	Assume each groundwater sample analyzed for metals, VOCs, and SVOCs. Quality control samples include 1 field duplicate, 1 equipment blank, and 1 trip blank.
OM.2.4	Data Validation	Assume 40 HRS (approximately 1 HR per sample) for data validation at $100/HR.
OM.2.5	Reporting	Assume $10,000 per quarter for preparation of data summary reports.

TABLE GW-2
ALTERNATIVE GW-2 CAPITAL COSTS
POND INTERCEPT WITH MONITORING AND INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0 Institutional Controls						
1.1	Legal Fees, Deed Restrictions, Property Surveys	10	EA	$20,000	$200,000	10 properties within GW plume
	Subtotal				**$200,000**	
2.0 Monitoring Well Construction						
2.1	Mobilize Drill Rig and Crew	1	LS	$2,700.00	$2,700	Means 2004 ER, 33 01 0101
2.2	Drilling (Assume 45 Wells, 30 LF Avg Depth)	1,350	LF	$16.76	$22,626	Means 2004 ER, 33 02 0601
2.3	Install PVC Well Screens (2" diameter)	450	LF	$14.28	$6,426	Means 2004 ER, 33 23 0201
2.4	Install PVC Well Casing (2" diameter)	900	LF	$10.16	$9,144	Means 2004 ER, 33 23 0101
2.5	Install Filter Pack	540	LF	$10.65	$5,751	Means 2004 ER, 33 23 1401
2.6	Install Bentonite Seal	45	EA	$39.29	$1,768	Means 2004 ER, 33 23 2101
2.7	Install Annular Seal	180	LF	$47.40	$8,532	Means 2004 ER, 33 23 1801
2.8	PVC Well Plugs	45	EA	$19.12	$860	Means 2004 ER, 33 23 0301
2.9	Flush-Mount Protective Cover with Locking Cap	24	EA	$309.97	$7,439	Means 2004 ER, 33 23 2211
2.10	Above-Ground Protective Casing with Locking Cap	21	EA	$297.41	$6,246	Means 2004 ER, 33 23 2251
2.11	Surface Pad, Concrete 2' x 2'	15	EA	$115.30	$1,730	Means 2004 ER, 33 23 1504
2.12	Well Development (2 HR/WELL)	45	EA	$170.00	$7,650	[1]
2.13	IDW Transportation/Disposal (drums)	110	EA	$285.00	$31,350	[1]
	Subtotal				**$73,222**	
TOTAL DIRECT COSTS					**$273,222**	
3.0 Other Costs						
3.1	Project Management (8%)				$21,858	OSWER 9355.0-75
3.2	Engineering and Design (15%)				$40,983	OSWER 9355.0-75
3.3	Construction Management (10%)				$27,322	OSWER 9355.0-75
3.4	Location Adjustment (10%)				$27,322	Means 2004 ER
3.5	Contingency (15%)				$40,983	OSWER 9355.0-75
TOTAL OTHER COSTS					**$158,469**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE GW-2					**$431,691**	

Notes:

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.

[1] Best estimate based on previous experience.

TABLE GW-2-OM
ALTERNATIVE GW-2 OPERATIONS AND MAINTENANCE COSTS
POND INTERCEPT WITH MONITORING AND INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual O&M Costs						
OM.1.1	Sample Collection Labor (45 wells/quarter)	640	HR	$85	$54,400	[1]
OM.1.2	Sampling Equipment Rental	4	EA	$2,000	$8,000	[1]
OM.1.3	Groundwater Sample Analyses (50 samples/quarter)					
1.3.1	*Metals (Arsenic)*	200	EA	$125	$25,000	[1]
1.3.2	*VOCs*	200	EA	$200	$40,000	[1]
1.3.3	*SVOCs*	200	EA	$300	$60,000	[1]
OM.1.4	Data Validation	4	EA	$20,000	$80,000	[1]
OM.1.5	Reporting	4	EA	$15,000	$60,000	[1]
	Subtotal				**$327,400**	
TOTAL ANNUAL O&M COSTS					**$327,400**	
OM.2.0 Other O&M Costs						
OM.2.1	Project Management (10%)				$32,740	OSWER 9355.0-75
OM.2.2	O&M Contingency (15%)				$49,110	OSWER 9355.0-75
TOTAL OTHER O&M COSTS					**$81,850**	
ANNUAL O&M COSTS ALTERNATIVE GW-2					**$409,250**	

Notes:
[1] Best estimate based on previous experience.
Present worth analysis includes periodic cost of $50,000 for preparation of five-year review.
Present worth analysis assumes the costs in this table would be incurred in years 1 - 5, and for years 6-30, groundwater monitoring would be conducted on a semi-annual basis.

TABLE GW-2-PW
ALTERNATIVE GW-2 PRESENT WORTH ANALYSIS
POND INTERCEPT WITH MONITORING AND INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$431,691	$0	$0	$431,691	7.0%	1.000	$431,691
1	$0	$409,250	$0	$409,250	7.0%	0.935	$382,477
2	$0	$409,250	$0	$409,250	7.0%	0.873	$357,455
3	$0	$409,250	$0	$409,250	7.0%	0.816	$334,070
4	$0	$409,250	$0	$409,250	7.0%	0.763	$312,215
5	$0	$409,250	$50,000	$459,250	7.0%	0.713	$327,439
6	$0	$204,625	$0	$204,625	7.0%	0.666	$136,350
7	$0	$204,625	$0	$204,625	7.0%	0.623	$127,430
8	$0	$204,625	$0	$204,625	7.0%	0.582	$119,094
9	$0	$204,625	$0	$204,625	7.0%	0.544	$111,302
10	$0	$204,625	$50,000	$254,625	7.0%	0.508	$129,438
11	$0	$204,625	$0	$204,625	7.0%	0.475	$97,216
12	$0	$204,625	$0	$204,625	7.0%	0.444	$90,856
13	$0	$204,625	$0	$204,625	7.0%	0.415	$84,912
14	$0	$204,625	$0	$204,625	7.0%	0.388	$79,357
15	$0	$204,625	$50,000	$254,625	7.0%	0.362	$92,288
16	$0	$204,625	$0	$204,625	7.0%	0.339	$69,314
17	$0	$204,625	$0	$204,625	7.0%	0.317	$64,779
18	$0	$204,625	$0	$204,625	7.0%	0.296	$60,541
19	$0	$204,625	$0	$204,625	7.0%	0.277	$56,581
20	$0	$204,625	$50,000	$254,625	7.0%	0.258	$65,800
21	$0	$204,625	$0	$204,625	7.0%	0.242	$49,420
22	$0	$204,625	$0	$204,625	7.0%	0.226	$46,187
23	$0	$204,625	$0	$204,625	7.0%	0.211	$43,165
24	$0	$204,625	$0	$204,625	7.0%	0.197	$40,341
25	$0	$204,625	$50,000	$254,625	7.0%	0.184	$46,914
26	$0	$204,625	$0	$204,625	7.0%	0.172	$35,236
27	$0	$204,625	$0	$204,625	7.0%	0.161	$32,930
28	$0	$204,625	$0	$204,625	7.0%	0.150	$30,776
29	$0	$204,625	$0	$204,625	7.0%	0.141	$28,763
30	$0	$204,625	$50,000	$254,625	7.0%	0.131	$33,449
	$431,691	$7,161,875	$300,000	$7,893,566			**$3,917,784**

TABLE GW-2-A
ALTERNATIVE GW-2 COST ASSUMPTIONS
POND INTERCEPT WITH MONITORING AND INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
	CAPITAL COSTS (TABLE GW-2)	
General Assumptions		
	Alternative GW-2 is a limited action alternative that involves groundwater monitoring within the delineated groundwater contamination plumes (Figure 2-4). Institutional controls would be imposed on each property that is located within the groundwater contamination areas to limit or prevent activities that might result in future exposures to contaminants in groundwater.	
	For the purposes of estimating cost for the FS, it was assumed that the monitoring well network that would be used to monitor groundwater concentrations would consist of 15 well clusters, each cluster consisting of a well screened in the shallow, intermediate, and deep portions of the overburden aquifer. It wa assumed that the depth of shallow wells would be 15 feet bgs, intermediate wells 30 feet bgs, and deep wells 45 feet bgs; therefore the average depth of monitoring wells would be 30 feet and the total linear footage of monitoring wells would be 45 * 30 = 1,350 LF.	
1.0 Institutional Controls		
	Institutional controls, in the form of deed restrictions, would be placed on 10 properties to restrict activities and groundwater uses that might result in future exposures to contaminated groundwater that would present unacceptable human health risks.	
1.1	Legal Fees, Deed Restrictions, Site Surveys	Legal fees associated with drafting and implementing deed restrictions, costs to perform property surveys at $20,000 per property.
2.0 Monitoring Well Construction		
	For the purpose of developing capital costs for this alternative, a monitoring well network consisting of 15 monitoring wells was assumed. Since no active remediation would occur under this alternative, capital costs would only include costs to construct monitoring wells.	
2.1	Mobilize Drill Rig and Crew	Crew ULADB: Hollow-stem auger drill rig, 1 equipment operator, 2 laborers.
		Hourly rate = $340. Labor costs included in unit costs (2.2 through 2.10)
2.2	Drilling (Assume 45 Wells, 30 LF Depth)	45 wells * 30 LF = 1350 LF wells.
		Hollow-stem auger drilling, 8" diameter borehole, depth <= 100 feet.
		Production rate = 14 LF/HR.
		Assumed duration of drilling activities≈ 1350 LF / 14 LF/HR ≈ 100 HR.
2.3	Install PVC Well Screens	2" Schedule 40 PVC well screen, 10 LF/WELL = 450 LF.
		Production rate = 37.5 LF/HR.
		Assumed duration of screen installation = 450 LF / 37.5 LF/HR≈ 12 HR.
2.4	Install PVC Well Casing	2" Schedule 40 PVC riser, 20 LF/WELL = 900 LF.
		Production rate = 37.5 LF/HR.
		Assumed duration of casing installation = 900 LF / 37.5 LF/HR≈ 24 HR.
2.5	Install Filter Pack	Filter pack for 2" screen, 12 LF/WELL = 540 LF.
		Production rate = 44 LF/HR.
		Assumed duration of filter pack installation = 540 LF / 44 LF/HR≈ 12 HR.
2.6	Install Bentonite Seal	Bentonite seal for 2" well assumed two-foot thickness per well for 90 LF total.
2.7	Install Annular Seal	Annular seal (grout) for 2" well assumed 10 FT/well for 450 LF total.
2.8	PVC Well Plugs	2" PVC well plug, one per well.
2.9	Flush-Mount Protective Cover with Locking Cap	2" well finish, flush-mount with 8" x 7.5" waterproof manhole, locking cap.
		Assume approximately half of wells finished with flush-mount protective covers.
2.10	Above-Ground Protective Casing with Locking Cap	4" x 4' protective enclosure, Schedule 40, lockable with hinged lid.
		Assume approximately half of wells finished with above-ground protective covers.
2.11	Surface Pad, Concrete 2' x 2'	Concrete surface pad, 2' x 2' x 4", one per well.
2.12	Well Development	Assume 2 HRS per well for well development. Labor at $85/HR.
2.13	IDW Transportation/Disposal	Soil IDW generated: 3.14*(0.333 LF)^2 * 1350 LF ≈ 470 CF.
		470 CF soil / 1 CF/7.48 GAL ≈ 3,500 GAL soil or approximately 65 drums.
		Assume 1 drum per well development water.
		Total drums IDW developed assumed to be 110.
	OPERATIONS AND MAINTENANCE COSTS (TABLE GW-2-OM)	
OM.1.0 Annual O&M Costs		
	Annual O&M Costs for Alternative GW-2 were assumed to consist of periodic groundwater monitoring events and reporting of data and results. For the purpose of estimating present worth costs for this alternative, it was assumed that groundwater monitoring would be conducted quarterly for the first five years and semi-annually thereafter. The costs shown on Table GW-2-OM reflect those for the first five years (quarterly groundwater monitoring). Present worth analysis for years to 30 assumed that monitoring costs would be half of those presented on Table GW-2-OM (i.e. sampling conducted semi-annually rather than quarterly).	
OM.1.1	Sample Collection Labor	Assume labor for collection of samples from 45 wells at 3 HR/WELL = 135 HR.
		Assume 25 hours per sampling event for sample processing, paperwork, and shipping.
		160 hours per sampling event * 4 events/year = 640 hours per year.
OM.1.2	Sampling Equipment Rental	$2000 per event for 2 week rental of groundwater pumps, multiparameter water quality meters, turbidity meters, water level measurement probes, field vehicle.
OM.1.3	Groundwater Sample Analyses	Assume each groundwater sample analyzed for metals, VOCs, and SVOCs.
		Quality control samples include 2 field duplicates, 2 equipment blanks, and 1 trip blank.
OM.1.4	Data Validation	Assume 200 HRS (1 HR per sample) for data validation at $100/HR.
OM.1.5	Reporting	Assume $15,000 per quarter for preparation of data summary reports.

TABLE GW-3
ALTERNATIVE GW-3 CAPITAL COSTS
PLUME INTERCEPT BY GROUNDWATER EXTRACTION, TREATMENT, AND DISCHARGE, AND MONITORING WITH INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0 Institutional Controls						
1.1	Legal Fees, Deed Restrictions, Property Surveys	10	EA	$20,000	$200,000	10 properties within GW plume
	Subtotal				**$200,000**	
2.0 Mobilization/Demobilization						
2.1	Equipment/Materials/Labor Mobilization	1	LS	$30,000	$30,000	[1]
2.2	Field Support Facilities	1	LS	$5,000	$5,000	[1]
2.3	Monthly Costs associated with Field Support	6	MONTH	$4,000	$24,000	[1]
	Subtotal				**$59,000**	
3.0 In-Situ Enhanced Bioremediation - Benzene Plume at West Hide Pile						
3.1	Drilling Oversight (Assume Two Rigs - 20,000 LF)	700	HR	$85.00	$59,500	500 injection points [1]
3.2	Direct Push Borings - Geoprobe (300 LF/DAY)	70	DAY	$1,200.00	$84,000	TDS, 2005
3.3	Oxidant Injection	75	TON	$16,000.00	$1,200,000	Regenesis, 2005
3.4	IDW Disposal	250	EA	$285.00	$71,250	[1]
3.5	Boring Abandonment	1	LS	$43,150.00	$43,150	[1]
	Subtotal				**$1,457,900**	
4.0 Extraction Well Installation						
4.1	Mobilize Drill Rig and Crew	1	LS	$5,400.00	$5,400	Means 2004 ER, 33 01 0101
4.2	Drilling (Assume 5 Wells, 40 LF Depth, 14" borehole)	200	LF	$40.00	$8,000	Means 2004 ER, 33 23 1105
4.3	Install 8" PVC Well Screens	150	LF	$45.00	$6,750	Means 2004 ER, 33 23 0204
4.4	Install 8" PVC Well Casing	50	LF	$23.00	$1,150	Means 2004 ER, 33 23 0104
4.5	Install Silica Sand Filter Pack	175	LF	$30.00	$5,250	Means 2004 ER, 33 23 1403
4.6	Install Bentonite Seal	5	EA	$215.00	$1,075	Means 2004 ER, 33 23 2105
4.7	Well Vaults	5	EA	$4,000.00	$20,000	Means 2004 ER, 33 23 2205
4.8	Well Development (2 HR/WELL)	10	HR	$85.00	$850	[1]
4.9	IDW Transportation/Disposal (drums)	25	EA	$285.00	$7,125	[1]
	Subtotal				**$55,600**	
5.0 Installation of Treatment System Piping						
5.1	Site Preparation/Erosion Controls	6000	LF	$3.73	$22,380	Means 2004 HC, 02370 700 1250
5.2	Excavate Pipe Trenches	1200	CY	$5.00	$6,000	Means 2004 HC, 02315 610 0090
5.3	Place and Compact Pipe Bedding in Trench	150	CY	$17.00	$2,550	Means 2004 HC, 02315 640 0200
5.4	PVC Pipe Installation	3000	LF	$11.00	$33,000	Means 2004 ER, 33 26 0416
5.5	Pipe Fittings (reducers, elbows, tees)	1	LS	$3,000.00	$3,000	[1]
5.6	Backfill/Compact Trenches	1365	CY	$6.00	$8,190	Means 2004 ER, 02315 610 3040
5.7	Wellhead Completion (valves, etc)	5	EA	$2,000.00	$10,000	[1]
	Subtotal				**$85,120**	
6.0 Treatment Equipment						
6.1	Extraction Well Pumps	5	EA	$5,000	$25,000	[1]
6.2	Equalization Tank	4	EA	$4,000	$16,000	[1]
6.3	Chemical Oxidation System (KMnO4)	1	EA	$20,000	$20,000	[1]
6.4	Polymer Feed System	1	EA	$22,000	$22,000	[1]
6.5	Acid/Base Feed System	3	EA	$7,500	$22,500	[1]
6.6	Polymer Feed System	1	EA	$20,000	$20,000	[1]
6.7	Inclined Plate Clarifier	1	EA	$70,000	$70,000	[1]
6.8	Sludge Tank	1	EA	$40,000	$40,000	[1]
6.9	Aeration Equipment	2	EA	$10,000	$20,000	[1]
6.10	Scubber Equipment pkg	2	EA	$60,000	$120,000	Means 2004 ER, 33 13 9102
6.11	Activated Carbon Vessels	2	EA	$25,000	$50,000	[1]
6.12	Greensand Filter System	1	EA	$150,000	$150,000	[1]
6.13	Mechanical Installation	1	LS	$141,750	$141,750	[1]
6.14	Electrical Installation	1	LS	$85,050	$85,050	[1]
6.15	Instrumentation/Controls	1	LS	$75,000	$75,000	[1]
6.16	Pre-Engineered Steel Building (including site prep)	10,000	SF	$10	$100,000	[1]
	Subtotal				**$977,300**	
7.0 System Startup/Testing						
7.1	Labor	750	HR	$85.00	$63,750	[1]
7.2	Prepare O&M Manual	1	LS	$10,000	$10,000	[1]
7.3	Prepare As-Built Drawings	1	LS	$20,000	$20,000	[1]
7.4	Baseline Sampling Event	1	LS	$212,400	$212,400	[1]
	Subtotal				**$93,750**	

TABLE GW-3
ALTERNATIVE GW-3 CAPITAL COSTS
PLUME INTERCEPT BY GROUNDWATER EXTRACTION, TREATMENT, AND DISCHARGE, AND MONITORING WITH INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
8.0 Monitoring Well Construction						
8.1	Mobilize Drill Rig and Crew	1	LS	$2,700.00	$2,700	Means 2004 ER, 33 01 0101
8.2	Drilling (Assume 45 Wells, 30 LF Avg Depth)	1,350	LF	$16.76	$22,626	Means 2004 ER, 33 02 0601
8.3	Install PVC Well Screens (2" diameter)	450	LF	$14.28	$6,426	Means 2004 ER, 33 23 0201
8.4	Install PVC Well Casing (2" diameter)	900	LF	$10.16	$9,144	Means 2004 ER, 33 23 0101
8.5	Install Filter Pack	540	LF	$10.65	$5,751	Means 2004 ER, 33 23 1401
8.6	Install Bentonite Seal	45	EA	$39.29	$1,768	Means 2004 ER, 33 23 2101
8.7	Install Annular Seal	180	LF	$47.40	$8,532	Means 2004 ER, 33 23 1801
8.8	PVC Well Plugs	45	EA	$19.12	$860	Means 2004 ER, 33 23 0301
8.9	Flush-Mount Protective Cover with Locking Cap	24	EA	$309.97	$7,439	Means 2004 ER, 33 23 2211
8.10	Above-Ground Protective Casing with Locking Cap	21	EA	$297.41	$6,246	Means 2004 ER, 33 23 2251
8.11	Surface Pad, Concrete 2' x 2'	15	EA	$115.30	$1,730	Means 2004 ER, 33 23 1504
8.12	Well Development (2 HR/WELL)	45	EA	$170.00	$7,650	[1]
8.13	IDW Transportation/Disposal (drums)	100	EA	$285.00	$28,500	[1]
	Subtotal				**$109,372**	
TOTAL DIRECT COSTS					**$3,038,042**	
9.0 Other Costs						
9.1	Project Management (6%)				$182,283	OSWER 9355.0-75
9.2	Engineering and Design (12%)				$364,565	OSWER 9355.0-75
9.3	Construction Management (8%)				$243,043	OSWER 9355.0-75
9.4	Location Adjustment (10%)				$303,804	Means 2004 ER
9.5	Contingency (20%)				$607,608	OSWER 9355.0-75
TOTAL OTHER COSTS					**$1,701,303**	
TOTAL CAPITAL COST FOR ALTERNATIVE GW-3					**$4,739,345**	

Notes:
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE GW-3-OM
ALTERNATIVE GW-3 OPERATIONS AND MAINTENANCE COSTS
PLUME INTERCEPT BY GROUNDWATER EXTRACTION, TREATMENT, AND DISCHARGE,
AND MONITORING WITH INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0	**Operating/Supervision Labor**					
OM.1.1	Technician Labor (56 HR/WK)	2,920	HR	$85.00	$248,200	[1]
OM.1.2	Engineer Labor (8 HR/WK)	400	HR	$100.00	$40,000	[1]
OM.1.3	Equipment Maintenance (5% equipment cost)	1	LS	$21,675	$21,675	[1]
	Subtotal				**$309,875**	
OM.2.0	**Groundwater and Process Water Monitoring and Analysis**					
OM.2.1	Sample Collection Labor (160 HR/EVENT)	640	HR	$85	$54,400	[1]
OM.2.2	Sampling Equipment Rental	4	EA	$2,000	$8,000	[1]
OM.2.3	Groundwater Sample Analyses (50 samples/quarter)					
2.3.1	*Metals (Arsenic)*	200	EA	$125	$25,000	[1]
2.3.2	*VOCs*	200	EA	$200	$40,000	[1]
2.3.3	*SVOCs*	200	EA	$300	$60,000	[1]
OM.2.4	Process Water Samples (assume 25 monthly)					
2.4.1	*Metals (Arsenic)*	300	EA	$125	$37,500	[1]
2.4.2	*VOCs*	300	EA	$200	$60,000	[1]
2.4.3	*SVOCs*	300	EA	$300	$90,000	[1]
OM.2.5	Data Validation	500	EA	$100	$50,000	[1]
	Subtotal				**$424,900**	
OM.3.0	**Treatment System O&M**					
OM.3.1	Sludge Transportation and Disposal	100,000	GAL	$1.50	$150,000	[1]
OM.3.2	Chemicals (KMnO4, NaOH, HCl, polymer)	1	LS	$20,000	$20,000	[1]
OM.3.3	Carbon Replacement	4	EA	$4,000	$16,000	[1]
OM.3.4	Electrical Power Usage (100+ HP assumed)	650,000	KW-H	$0.11	$71,500	[1]
OM.3.5	Miscellaneous Facilities Support					
3.5.1	*Trash/Sanitary Facilities*	12	MONTH	$200.00	$2,400	[1]
3.5.2	*Snow Removal (per year)*	1	LS	$2,000.00	$2,000	[1]
	Subtotal				**$257,500**	
OM.4.0	**Reporting**					
OM.4.1	Reporting	4	EA	$20,000	$80,000	[1]
	Subtotal				**$80,000**	
TOTAL ANNUAL O&M COSTS (YEARS 1-2)					**$1,072,275**	
TOTAL ANNUAL O&M COSTS (YEARS 3-30)*					**$859,825**	
OM.5.0A	**Other O&M Costs (Years 1-2)**					
OM.5.1	Project Management (6%)				$64,337	OSWER 9355.0-75
OM.5.2	O&M Contingency (15%)				$160,841	OSWER 9355.0-75
TOTAL OTHER O&M COSTS (YEARS 1-2)					**$225,178**	
OM.5.0.B	**Other O&M Costs (Years 3-30)**					
OM.5.1	Project Management (6%)				**$51,590**	OSWER 9355.0-75
OM.5.2	O&M Contingency (15%)				**$128,974**	OSWER 9355.0-75
TOTAL OTHER O&M COSTS (YEARS 3-30)					**$180,563**	
ANNUAL O&M COSTS ALTERNATIVE GW-3 (YEARS 1-2					**$1,297,453**	
ANNUAL O&M COSTS ALTERNATIVE GW-3 (YEARS 3-30)					**$1,040,388**	

Notes:

* Annual O&M Costs for years 3-30 include semiannual groundwater monitoring and bimonthly process water sampling.

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.

Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.

[1] Best estimate based on previous experience.

TABLE GW-3-PW
ALTERNATIVE GW-3 PRESENT WORTH ANALYSIS
PLUME INTERCEPT BY GROUNDWATER EXTRACTION, TREATMENT, AND DISCHARGE, AND MONITORING WITH INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$4,739,345	0	$0	$4,739,345	7.0%	1.000	$4,739,345
1	$0	$1,297,453	$0	$1,297,453	7.0%	0.935	$1,212,573
2	$0	$1,297,453	$0	$1,297,453	7.0%	0.873	$1,133,245
3	$0	$1,040,388	$0	$1,040,388	7.0%	0.816	$849,267
4	$0	$1,040,388	$0	$1,040,388	7.0%	0.763	$793,707
5	$0	$1,040,388	$1,300,000	$2,340,388	7.0%	0.713	$1,668,664
6	$0	$1,040,388	$0	$1,040,388	7.0%	0.666	$693,255
7	$0	$1,040,388	$0	$1,040,388	7.0%	0.623	$647,902
8	$0	$1,040,388	$0	$1,040,388	7.0%	0.582	$605,515
9	$0	$1,040,388	$0	$1,040,388	7.0%	0.544	$565,902
10	$0	$1,040,388	$50,000	$1,090,388	7.0%	0.508	$554,298
11	$0	$1,040,388	$0	$1,090,388	7.0%	0.475	$518,036
12	$0	$1,040,388	$0	$1,040,388	7.0%	0.444	$461,945
13	$0	$1,040,388	$0	$1,040,388	7.0%	0.415	$431,724
14	$0	$1,040,388	$0	$1,040,388	7.0%	0.388	$403,481
15	$0	$1,040,388	$50,000	$1,090,388	7.0%	0.362	$395,207
16	$0	$1,040,388	$0	$1,040,388	7.0%	0.339	$352,415
17	$0	$1,040,388	$0	$1,040,388	7.0%	0.317	$329,360
18	$0	$1,040,388	$0	$1,040,388	7.0%	0.296	$307,813
19	$0	$1,040,388	$0	$1,040,388	7.0%	0.277	$287,676
20	$0	$1,040,388	$50,000	$1,090,388	7.0%	0.258	$281,777
21	$0	$1,040,388	$0	$1,040,388	7.0%	0.242	$251,267
22	$0	$1,040,388	$0	$1,040,388	7.0%	0.226	$234,829
23	$0	$1,040,388	$0	$1,040,388	7.0%	0.211	$219,467
24	$0	$1,040,388	$0	$1,040,388	7.0%	0.197	$205,109
25	$0	$1,040,388	$50,000	$1,090,388	7.0%	0.184	$200,903
26	$0	$1,040,388	$0	$1,040,388	7.0%	0.172	$179,150
27	$0	$1,040,388	$0	$1,040,388	7.0%	0.161	$167,430
28	$0	$1,040,388	$0	$1,040,388	7.0%	0.150	$156,477
29	$0	$1,040,388	$0	$1,040,388	7.0%	0.141	$146,240
30	$0	$1,040,388	$50,000	$1,090,388	7.0%	0.131	$143,241
	$4,739,345	**$31,725,777**	**$1,550,000**	**$38,065,122**			**$19,137,221**

TABLE GW-3-A
ALTERNATIVE GW-3 COST ASSUMPTIONS
PLUME INTERCEPT BY GROUNDWATER EXTRACTION, TREATMENT, AND DISCHARGE, AND MONITORING WITH INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
		CAPITAL COSTS (TABLE GW-3)
General Assumptions		
	Alternative GW-3 involves the construction of a groundwater extraction/treatment system that captures the entire area of arsenic/benzene groundwater contamination that is depicted on Figure 2-4. Treatment of groundwater contaminated with benzene that is located in the vicinity of the West Hide Pile wou be accomplished through in-situ enhanced bioremediation by injecting an oxygen-enhancing slurry into the aquifer through a series of soil borings advanced throughout the delineated contaminant plume.	
	Since this alternative would not achieve remediation goals in the short term, institutional controls would be imposed on each property that is located within the groundwater contamination areas to limit or prevent activities that might result in future exposures to contaminants in groundwater. For the purposes of estimating costs for the FS, it was assumed that the groundwater contamination plume is located on all or portions of 10 properties.	
1.0 Institutional Controls		
	Institutional controls, in the form of deed restrictions, would be placed on 10 properties to restrict activities and groundwater uses that might result in future exposures to contaminated groundwater that would present unacceptable human health risks.	
1.1	Legal Fees, Deed Restrictions, Site Surveys	Legal fees associated with drafting and implementing deed restrictions, costs to perform property surveys at $20,000 per property.
2.0 Mobilization/Demobilization		
2.1	Equipment Mobilization	Assume less than 50 mile haul distance for all equipment.
		Equipment would be mobilized and demobilized to and from the site once for this project.
		Assume $200 for mob, $200 for demob per piece of equipment.
		Unit costs include labor cost for equipment mob/demob.
2.2	Field Support Facilities	Field support facilities will be mobilized and demobilized to and from the central field support area once during the course of the project.
		The following items are included in this cost line item: office trailer @ $500, storage trailer @ $500, dumpster @ $100, sanitary facilities @ $100, soil sampling equipment @ $2000.
2.3	Monthly Costs associated with Field Support	Includes monthly rental costs for duration of project for the following: office trailer @ $400, storage trailer @ $200, utilities @ $200, dumpster @ $200, sampling materials @ $1250, air sampling equipment (PID) @ 750.
3.0 In-Situ Enhanced Bioremediation - Benzene Plume at West Hide Pile		
	The assumed area of the oxygen injection area was 280 FT x 400 FT. The depth to groundwater was assumed to average 20 FT below ground surface, and the thickness of the contaminated groundwater zone was assumed to be 20 LF (40 FT depth below ground surface). Injection points were assumed to be installed in a grid with points 15 feet on center along the length and width of the contaminated area.	
3.1	Drilling Oversight	Assume 500 injection points, 40 LF per point = 20,000 LF drilling.
		20,000 LF / 300 LF/DAY = 67 DAY drilling. Assume 70 DAY * 10 HR/DAY oversight = 700 HR.
3.2	Direct Push Borings	$1,200/DAY rate for GeoProbe based on quote from drilling contractor.
3.3	Oxidant Injection	75 TONS oxidant * $8/LB * 2000 LB/TON = $1,200,000. Quantity based on vendor-supplied cost estimating spreadsheet. Oxidant cost provided by vendor.
3.4	IDW Disposal	Drilling spoils for one 4-inch boring≈ (3.14)*(2/12 LF)^2*(40 LF) ≈ 3.5 CF.
		500 borings * 3.5 CF/boring ≈ 1,750 CF.
		1,750 CF * 7.48 GAL/CF ≈ 13,000 GAL. Assume 250 55-gallon drums IDW.
3.5	Boring Abandonment	Soil boring abandonment would involve backfilling the portions of the soil boring that are located abov the water table using clean fill material.
		1,750 CF ≈ 65 CY. Assume $10/CY for material. 1 HR labor per boring @ $85/HR.
		$650 for material. $42,500 labor cost.
4.0 Extraction Well Installation		
4.1	Mobilize Drill Rig and Crew	Mobilize hollow-stem auger drilling rig to site, <50 mile mobilization distance.
		Crew ULADB: Hollow-stem auger drill rig, 1 equipment operator, 2 laborers.
		Hourly rate = $340. Labor costs included in unit costs (4.2 through 4.9)
4.2	Drilling (14" borehole)	Assume 5 extraction wells, 40 LF average depth = 200 LF total.
		Hollow-stem auger drilling, 14" diameter borehole, depth <= 100 feet.
		Production rate = 9 LF/HR.
		Assumed duration of drilling activities≈ 200 LF / 9 LF/HR ≈ 22 HR.
4.3	Install 8" PVC Well Screens	8" PVC well screen, Schedule 40.
		Production rate = 12.5 LF/HR.
		150 LF / 12 LF/HR = 12.5 HR.
4.4	Install 8" PVC Well Casing	8" PVC well casing, Schedule 40.
		Production rate = 12.5 LF/HR.
		50 LF / 12.5 LF/HR = 4 HR.
4.5	Install Silica Sand Filter Pack	Filter pack for 8" screen, 35 LF/well = 175 LF.
4.6	Install Bentonite Seal	Bentonite seal for 8" well. One per well = 5 total.
4.7	Well Vaults	Traffic load, well protective vaults, 4' x 4' with locking hatch.
4.8	Well Development	Assume 2 HRS per well for well development. Labor at $85/HR.
4.9	IDW Transportation/Disposal (drums)	IDW generated per boring = (3.14)*(7/12 LF)^2*40 LF ≈ 42.7 CF.
		42.7 CF * 7.48 GAL/CF ≈ 319 GAL. Assume six 55-gallon drums for soil IDW. Assume twenty 55 gallon drums (4 per well) for well development water.

TABLE GW-3-A
ALTERNATIVE GW-3 COST ASSUMPTIONS
PLUME INTERCEPT BY GROUNDWATER EXTRACTION, TREATMENT, AND DISCHARGE, AND MONITORING WITH INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
5.0 Installation of Treatment System Piping		
The treatment system piping system that would be installed for the groundwater extraction system was assumed to require 3000 LF of PVC pipe to connect each of the extraction wells to the groundwater treatment plant.		
5.1	Site Preparation/Erosion Controls	Assume 6000 LF of silt fence/straw bales in areas where trenches are being excavated for the purpose of installing pipe.
5.2	Excavate Pipe Trenches	Assume pipe trenches 4 feet deep, 4 feet wide = 16 SF cross sectional area.
		Length of trenches ≈ 2000 LF * 16 SF ≈ 32,000 CF.
		32,000 CF / 27 CF/CY ≈ 1,200 CY
5.3	Place and Compact Pipe Bedding in Trench	Assume 6" sand pipe bedding in trenches.
		0.5 LF * 4 LF * 2000 LF = 4000 CF / 27 CF/CY ≈ 150 CY.
5.4	PVC Pipe Installation	Install 3000 LF of PVC pipe.
5.5	Pipe Fittings (reducers, elbows, tees)	Pipe fitting
5.6	Backfill/Compact Trenches	Assume (1200 CY - 150 CY) * 1.3 = 1365 CY.
6.0 Treatment System Equipment		
The cost estimates for purchase and installation of treatment system equipment are based on costs published in trade manuals (Blue Book, etc.), acquired from vendors, and developed from previous cost estimates for similar projects.		
OPERATIONS AND MAINTENANCE COSTS (TABLE GW-3-OM)		
Annual O&M Costs for Alternative GW-3 were assumed to consist of day-to-day treatment system operations and maintenance, periodic groundwater and process water monitoring events, and reporting of data and results. For the purpose of estimating present worth costs for this alternative, it was assumed that groundwater monitoring would be conducted quarterly for the first five years and semi-annually thereafter; and that process water sampling would occur monthly for the first five years, and bimonthly thereafter. The costs shown on Table GW-3-OM reflect those for the first five years (quarterly groundwater monitoring/monthly process water sampling). Present worth analysis for years 6 to 30 assumed that monitoring costs would be half of those presented on Table GW-2-OM (i.e. sampling conducted semi-annually/bi-monthly rather than quarterly/monthly).		
OM.1.0 Annual O&M Costs		
OM.1.1	Operating/Supervision Labor	Assume 8 HR/DAY, 56 HR/WEEK for treatment system operator.
OM.1.2	Engineer Labor	One day per week (8 HR) for engineer oversight.
OM.1.3	Equipment Maintenance	Assume 5% of equipment cost for regular maintenance.
OM.2.0 Groundwater and Process Water Monitoring and Analysis		
OM.2.1	Sample Collection Labor	Assume 160 HR per event to collect samples, process samples, prepare paperwork and shipments. 160 hours per sampling event * 4 events/year = 640 hours per year.
OM.2.2	Sampling Equipment Rental	$2000 per event for 2 week rental of groundwater pumps, multiparameter water quality meters, turbidity meters, water level measurement probes, field vehicle.
OM.2.3	Groundwater Sample Analyses	Assume each groundwater sample analyzed for metals, VOCs, and SVOCs.
		Quality control samples include 2 field duplicates, 2 equipment blanks, and 1 trip blank.
OM.2.4	Process Water Samples	Assume 25 samples per month analyzed for metals, VOCs, and SVOCs.
OM.2.5	Data Validation	Assume 500 HRS (1 HR per sample) for data validation at $100/HR.

TABLE GW-4
ALTERNATIVE GW-4 CAPITAL COSTS
PLUME INTERCEPT BY IN-SITU GROUNDWATER TREATMENT AND MONITORING WITH INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0 Pre-Design Investigations						
1.1	Treatability Testing - Enhanced Bioremediation	1	LS	$50,000.00	$50,000	[1]
1.2	Treatability Testing - Permeable Reactive Barrier	1	LS	$50,000.00	$50,000	[1]
1.3	Report Preparation	80	HR	$100.00	$8,000	[1]
	Subtotal				**$108,000**	
2.0 Institutional Controls						
2.1	Legal Fees, Deed Restrictions, Property Surveys	10	EA	$20,000	$200,000	10 properties within GW plume
	Subtotal				**$200,000**	
3.0 Mobilization/Demobilization						
3.1	Equipment/Materials/Labor Mob/Demob	1	LS	$20,000	$20,000	[1]
3.2	Field Support Facilities	1	LS	$5,000	$5,000	[1]
3.3	Monthly Costs associated with Field Support	8	MONTH	$4,000	$32,000	[1]
	Subtotal				**$57,000**	
4.0 In-Situ Enhanced Bioremediation - Benzene Plume at West Hide Pile						
4.1	Drilling Oversight (Assume Two Rigs - 20,000 LF)	700	HR	$85.00	$59,500	500 injection points [1]
4.2	Direct Push Borings - Geoprobe (300 LF/DAY)	70	DAY	$1,200.00	$84,000	TDS, 2005
4.3	Oxidant Injection	75	TON	$16,000.00	$1,200,000	Regenesis, 2005
4.4	IDW Disposal	250	EA	$285.00	$71,250	[1]
4.5	Boring Abandonment	1	LS	$43,150.00	$43,150	[1]
	Subtotal				**$1,457,900**	
5.0 In-Situ Enhanced Bioremediation - Benzene Plume in RX Area						
5.1	Drilling Oversight (Assume Two Rigs - 27,000 LF)	900	HR	$85.00	$76,500	900 injection points [1]
5.2	Direct Push Borings - Geoprobe (300 LF/DAY)	90	DAY	$1,200.00	$108,000	TDS, 2005
5.3	Oxidant Injection	90	TON	$16,000.00	$1,440,000	Regenesis, 2005
5.4	IDW Disposal	330	EA	$285.00	$94,050	[1]
5.5	Boring Abandonment	1	LS	$58,000.00	$58,000	[1]
	Subtotal				**$1,776,550**	
6.0 Permeable Reactive Barrier Construction						
6.1	Draft/Final Design and Specifications	1	LS	$130,000	$130,000	GeoSierra, 2005
6.2	PRB Construction, QA, and Verification Testing	1	LS	$3,800,000	$4,900,000	GeoSierra, 2005
	Subtotal				**$5,030,000**	
7.0 Monitoring Well Construction						
7.1	Mobilize Drill Rig and Crew	1	LS	$2,700.00	$2,700	Means 2004 ER, 33 01 0101
7.2	Drilling (Assume 60 Wells, 30 LF Avg Depth)	1,800	LF	$16.76	$30,168	Means 2004 ER, 33 02 0601
7.3	Install PVC Well Screens (2" diameter)	600	LF	$14.28	$8,568	Means 2004 ER, 33 23 0201
7.4	Install PVC Well Casing (2" diameter)	1,200	LF	$10.16	$12,192	Means 2004 ER, 33 23 0101
7.5	Install Filter Pack	720	LF	$10.65	$7,668	Means 2004 ER, 33 23 1401
7.6	Install Bentonite Seal	60	EA	$39.29	$2,357	Means 2004 ER, 33 23 2101
7.7	Install Annular Seal	240	LF	$47.40	$11,376	Means 2004 ER, 33 23 1801
7.8	PVC Well Plugs	60	EA	$19.12	$1,147	Means 2004 ER, 33 23 0301
7.9	Flush-Mount Protective Cover with Locking Cap	30	EA	$309.97	$9,299	Means 2004 ER, 33 23 2211
7.10	Above-Ground Protective Casing with Locking Cap	30	EA	$325.00	$9,750	Means 2004 ER, 33 23 2215
7.11	Surface Pad, Concrete 2' x 2'	60	EA	$115.30	$6,918	Means 2004 ER, 33 23 1504
7.12	Well Development	60	EA	$170.00	$10,200	[1]
7.13	IDW Transportation/Disposal (drums)	150	EA	$285.00	$42,750	[1]
	Subtotal				**$155,094**	
TOTAL DIRECT COSTS					**$8,784,544**	
8.0 Other Costs						
8.1	Project Management (5%)				$439,227	OSWER 9355.0-75
8.2	Engineering and Design (8%)				$702,763	OSWER 9355.0-75
8.3	Construction Management (6%)				$527,073	OSWER 9355.0-75
8.4	Location Adjustment (10%)				$878,454	Means 2004 ER
8.5	Contingency (20%)				$1,756,909	OSWER 9355.0-75
TOTAL OTHER COSTS					**$4,304,426**	
TOTAL COST FOR REMEDIAL ALTERNATIVE GW-4					**$13,088,970**	

Notes:
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE GW-4-OM
ALTERNATIVE GW-4 OPERATIONS AND MAINTENANCE COSTS
PLUME INTERCEPT BY IN-SITU GROUNDWATER TREATMENT AND MONITORING WITH INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual O&M Costs						
OM.1.1	Sample Collection Labor (60 wells/quarter)	800	HR	$85.00	$68,000	[1]
OM.1.2	Sampling Equipment Rental	4	EA	$2,000	$8,000	[1]
OM.1.3	Groundwater Sample Analyses (65 samples/quarter)					
1.3.1	*Metals (Arsenic)*	260	EA	$125	$32,500	[1]
1.3.2	*VOCs*	260	EA	$200	$52,000	[1]
1.3.3	*SVOCs*	260	EA	$300	$78,000	[1]
OM.1.4	Data Validation	260	HR	$100	$26,000	[1]
OM.1.5	Reporting	4	EA	$20,000	$80,000	[1]
	Subtotal				**$344,500**	
TOTAL ANNUAL O&M COSTS					**$344,500**	
OM.2.0 Other O&M Costs						
OM.2.1	Project Management (10%)				$34,450	
OM.2.2	O&M Contingency (20%)				$68,900	
TOTAL OTHER O&M COSTS					**$103,350**	
ANNUAL O&M COSTS ALTERNATIVE GW-4					**$447,850**	

Notes:

[1] Best estimate based on previous experience.

Present worth analysis includes periodic cost of $50,000 for preparation of five-year review.

Present worth analysis includes periodic costs in Years 10, 20, and 30 of $1,000,000 to replace reactive media.

TABLE GW-4-PW
ALTERNATIVE GW-4 PRESENT WORTH ANALYSIS
PLUME INTERCEPT BY IN-SITU GROUNDWATER TREATMENT AND MONITORING WITH INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$13,088,970	0	$0	$13,088,970	7.0%	1.000	$13,088,970
1	$0	$447,850	$0	$447,850	7.0%	0.935	$418,551
2	$0	$447,850	$0	$447,850	7.0%	0.873	$391,170
3	$0	$447,850	$0	$447,850	7.0%	0.816	$365,579
4	$0	$447,850	$0	$447,850	7.0%	0.763	$341,663
5	$0	$447,850	$50,000	$497,850	7.0%	0.713	$354,960
6	$0	$223,925	$0	$223,925	7.0%	0.666	$149,211
7	$0	$223,925	$0	$223,925	7.0%	0.623	$139,449
8	$0	$223,925	$0	$223,925	7.0%	0.582	$130,326
9	$0	$223,925	$0	$223,925	7.0%	0.544	$121,800
10	$0	$223,925	$1,050,000	$1,273,925	7.0%	0.508	$647,599
11	$0	$223,925	$0	$223,925	7.0%	0.475	$106,385
12	$0	$223,925	$0	$223,925	7.0%	0.444	$99,425
13	$0	$223,925	$0	$223,925	7.0%	0.415	$92,921
14	$0	$223,925	$0	$223,925	7.0%	0.388	$86,842
15	$0	$223,925	$50,000	$273,925	7.0%	0.362	$99,283
16	$0	$223,925	$0	$223,925	7.0%	0.339	$75,851
17	$0	$223,925	$0	$223,925	7.0%	0.317	$70,889
18	$0	$223,925	$0	$223,925	7.0%	0.296	$66,251
19	$0	$223,925	$0	$223,925	7.0%	0.277	$61,917
20	$0	$223,925	$1,050,000	$1,273,925	7.0%	0.258	$329,206
21	$0	$223,925	$0	$223,925	7.0%	0.242	$54,081
22	$0	$223,925	$0	$223,925	7.0%	0.226	$50,543
23	$0	$223,925	$0	$223,925	7.0%	0.211	$47,236
24	$0	$223,925	$0	$223,925	7.0%	0.197	$44,146
25	$0	$223,925	$50,000	$273,925	7.0%	0.184	$50,470
26	$0	$223,925	$0	$223,925	7.0%	0.172	$38,559
27	$0	$223,925	$0	$223,925	7.0%	0.161	$36,036
28	$0	$223,925	$0	$223,925	7.0%	0.150	$33,679
29	$0	$223,925	$0	$223,925	7.0%	0.141	$31,476
30	$0	$223,925	$1,050,000	$1,273,925	7.0%	0.131	$167,352
TOTAL	**$13,088,970**	**$7,837,375**	**$3,300,000**	**$24,226,345**			**$17,791,828**

TABLE GW-4-A
ALTERNATIVE GW-4 COST ASSUMPTIONS
PLUME INTERCEPT BY IN-SITU GROUNDWATER TREATMENT AND MONITORING WITH INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
General Assumptions		
	Alternative GW-4 would involve construction of a permeable reactive barrier (PRB) designed to intercept groundwater prior to discharge to the HBHA Pond. The PRB would be designed to remove arsenic from groundwater. This alternative would also involve in-situ enhanced bioremediation to treat benzene-contaminated groundwater at the two primary source areas (Atlantic Avenue source and West Hide Pile Source).	
	The treatment processes that would be used to implement this alternative would not be expected to decrease contaminant concentrations in the human health risk areas to levels below remediation goals in the foreseeable future. Therefore, in order to achieve the RAOs for groundwater, institutional controls would be implemented on each of the properties that would be impacted by the alternative.	
1.0 Pre-Design Investigations		
	Due to the fact that this alternative utilizes in-situ treatment technologies that are less developed than ex-situ treatment processes, and more sensitive to the site-specific hydrogeology and groundwater geochemistry, pre-design investigations would be performed for each treatment process to verify its effectiveness. Costs to perform investigations are based on information obtained from technology vendors.	
2.0 Institutional Controls		
	Institutional controls, in the form of deed restrictions, would be placed on 10 properties to restrict activities and groundwater uses that might result in future exposures to contaminated groundwater that would present unacceptable human health risks.	
1.1	Legal Fees, Deed Restrictions, Site Surveys	Legal fees associated with drafting and implementing deed restrictions, costs to perform property surveys at $20,000 per property.
3.0 Mobilization/Demobilization		
3.1	Equipment Mobilization	Assume less than 50 mile haul distance for all equipment.
		Equipment would be mobilized and demobilized to and from the site once for this project.
		Assume $200 for mob, $200 for demob per piece of equipment.
		Unit costs include labor cost for equipment mob/demob.
3.2	Field Support Facilities	Field support facilities will be mobilized and demobilized to and from the central field support area once during the course of the project.
		The following items are included in this cost line item: office trailer @ $500, storage trailer @ $500, dumpster @ $100, sanitary facilities @ $100, soil sampling equipment @ $2000.
3.3	Monthly Costs associated with Field Support	Includes monthly rental costs for duration of project for the following: office trailer @ $400, storage trailer @ $200, utilities @ $200, dumpster @ $200, sampling materials @ $1250, air sampling equipment (PID) @ 750.
		The following items are included in this cost line item: office trailer @ $500, storage trailer @ $500, dumpster @ $100, sanitary facilities @ $100, soil sampling equipment @ $2000.
4.0 In-Situ Enhanced Bioremediation - Benzene Plume at West Hide Pile		
	The assumed area of the oxygen injection area was 280 FT x 400 FT. The depth to groundwater was assumed to average 20 FT below ground surface, and the thickness of the contaminated groundwater zone was assumed to be 20 LF (40 FT depth below ground surface). Injection points were assumed to be installed in a grid with points 15 feet on center along the length and width of the contaminated area.	
4.1	Drilling Oversight	Assume 500 injection points, 40 LF per point = 20,000 LF drilling.
		20,000 LF / 300 LF/DAY = 67 DAY drilling. Assume 70 DAY * 10 HR/DAY oversight = 700 HR.
4.2	Direct Push Borings	$1,200/DAY rate for GeoProbe based on quote from drilling contractor.
4.3	Oxidant Injection	75 TONS oxidant * $8/LB * 2000 LB/TON = $1,200,000. Quantity based on vendor-supplied cost estimating spreadsheet. Oxidant cost provided by vendor.
4.4	IDW Disposal	Drilling spoils for one 4-inch boring≈ (3.14)*(2/12 LF)^2*(40 LF) ≈ 3.5 CF.
		500 borings * 3.5 CF/boring≈ 1,750 CF.
		1,750 CF * 7.48 GAL/CF ≈ 13,000 GAL. Assume 250 55-gallon drums IDW.
4.5	Boring Abandonment	Soil boring abandonment would involve backfilling the portions of the soil boring that are located above the water table using clean fill material.
		1,750 CF ≈ 65 CY. Assume $10/CY for material. 1 HR labor per boring @ $85/HR.
		$650 for material. $42,500 labor cost.
5.0 In-Situ Enhanced Bioremediation - Benzene Plume in RX Area		
	Section 4.0. For the purposes of developing estimates for this area, the treatment area was assumed to be approximately 600 FT x 350 FT in the RX benzene source area located along Atlantic Avenue. Injection points would be advanced in grid formation within this area (plume areas located beneath permanent buildings would not be accessed). The assumed depth to groundwater in this portion of the site was 10 feet bgs, and the treatment zone (thickness of contaminated groundwater zone) was assumed to be 20 feet.	
	For the purposes of estimating costs for the FS, it was assumed that remediation of the benzene source areas could be accomplished with one reagent injection. If remediation goals are not achieved after one injection (as determined through the groundwater monitoring program), a second injection may be warranted base on data trends and observations.	
6.0 Permeable Reactive Barrier		
	Costs to construct a PRB that intercepts groundwater before it discharges to the HBHA Pond were developed based on discussions with a vendor experienced with the design and construction of zero-valent iron reactive barriers. The "influent" concentration was assumed to be 1,110 ug/L and the treatment goal was 150 ug/L. The assumed length of the barrier was approximately 1,200 feet, and it was assumed to extend from 5 feet below ground surface to 45 feet below ground surface on average, although the actual barrier would follow the contours of the bedrock underlying the site. The assumed width of the barrier was 3 inches.	
7.0 Monitoring Well Construction		
	meeting remedial action objectives. In order to accomplish these goals, it was assumed that monitoring of groundwater at 60 monitoring wells would be necessary. Monitoring wells would be constructed in groups of three, with one well in each collocated group screened into the shallow, intermediate, and deep portions of the overburden aquifer. Well construction details and assumptions would be as described on Table GW-2-A for Alternative 2.	

TABLE GW-4-A
ALTERNATIVE GW-4 COST ASSUMPTIONS
PLUME INTERCEPT BY IN-SITU GROUNDWATER TREATMENT AND MONITORING WITH INSTITUTIONAL CONTROLS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		COST ESTIMATE BASIS
OPERATIONS AND MAINTENANCE COSTS (TABLE GW-4-OM		
OM.1.0 Annual O&M Costs		
Annual O&M Costs for Alternative GW-4 were assumed to consist of periodic groundwater monitoring events and reporting of data and results. For the purpose estimating present worth costs for this alternative, it was assumed that groundwater monitoring would be conducted quarterly for the first five years and semi-annually thereafter. The costs shown on Table GW-4-OM reflect those for the first five years (quarterly groundwater monitoring). Present worth analysis for years 6 to 30 assumed that monitoring costs would be half of those presented on Table GW-4-OM (i.e. sampling conducted semi-annually rather than quarterly).		
OM.1.1	Sample Collection Labor	Assume labor for collection of samples from 60 wells at 3 HR/well = 180 HR. Assume 20 hours per sampling event for sample processing, paperwork, and shipping. 200 hours per sampling event * 4 events/year = 800 hours per year.
OM.1.2	Sampling Equipment Rental	$2000 per event for 2 week rental of groundwater pumps, multiparameter water quality meters, turbidity meters, water level measurement probes, field vehicle.
OM.1.3	Groundwater Sample Analyses	Assume each groundwater sample analyzed for metals, VOCs, and SVOCs. Quality control samples include 2 field duplicates, 2 equipment blanks, and 1 trip blank.
OM.1.4	Data Validation	Assume 260 HRS (1 HR per sample) for data validation at $100/HR.
OM.1.5	Reporting	Assume $20,000 per quarter for preparation of data summary reports.

TABLE HBHA-2-OM
ALTERNATIVE HBHA-2 OPERATIONS AND MAINTENANCE COSTS
MONITORING - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual O&M Costs						
OM.1.1	Mobilize Sampling Equipment and Labor	4	LS	$1,000.00	$4,000	[1]
OM.1.2	Sediment Sample Collection Labor	360	HR	$85.00	$30,600	[1]
OM.1.3	Sediment Sampling Equipment Rental	4	EA	$2,000.00	$8,000	[1]
OM.1.4	Sediment Sampling Supplies	4	EA	$2,000.00	$8,000	[1]
OM.1.5	Sediment Sample Analysis (assume 10/quarter)					
1.5.1	*Metals (Arsenic)*	40	EA	$100.00	$4,000	[1]
1.5.2	*SVOCs*	40	EA	$250.00	$10,000	[1]
OM.1.6	Data Validation	80	HR	$100.00	$8,000	[1]
OM.1.7	Reporting	4	EA	$10,000.00	$40,000	[1]
TOTAL ANNUAL O&M COSTS (YEARS 1-2)					**$112,600**	
OM.2.0 Other O&M Costs						
OM.2.1	Project Management (10%)				$11,260	OSWER 9355.0-75
OM.2.2	O&M Contingency (15%)				$16,890	OSWER 9355.0-75
TOTAL OTHER O&M COSTS (YEARS 1-2)					**$28,150**	
ANNUAL O&M COSTS ALTERNATIVE HBHA-2 (YEARS 1-2)					**$140,750**	

Notes:

Capital costs would not be incurred under Alternative HBHA-2

Present worth analysis includes $50,000 every five years for five-year review.

Present worth analysis includes $50,000 in Year 5 for triad toxicity tests.

Present worth analysis assumes the costs in this table would be incurred in years 1 and 2, and for years 3-30, sediment monitoring would be conducted on a semi-annual basis.

[1] Best estimate based on previous experience.

TABLE HBHA-2-PW
ALTERNATIVE HBHA-2 PRESENT WORTH ANALYSIS
MONITORING - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$0	0	$0	$56,672	7.00%	1.000	$56,672
1	$0	$140,750	$0	$140,750	7.00%	0.935	$131,542
2	$0	$140,750	$0	$140,750	7.00%	0.873	$122,937
3	$0	$70,375	$0	$70,375	7.00%	0.816	$57,447
4	$0	$70,375	$0	$70,375	7.00%	0.763	$53,689
5	$0	$70,375	$100,000	$170,375	7.00%	0.713	$121,475
6	$0	$70,375	$0	$70,375	7.00%	0.666	$46,894
7	$0	$70,375	$0	$70,375	7.00%	0.623	$43,826
8	$0	$70,375	$0	$70,375	7.00%	0.582	$40,959
9	$0	$70,375	$0	$70,375	7.00%	0.544	$38,279
10	$0	$70,375	$50,000	$120,375	7.00%	0.508	$61,193
11	$0	$70,375	$0	$70,375	7.00%	0.475	$33,435
12	$0	$70,375	$0	$70,375	7.00%	0.444	$31,247
13	$0	$70,375	$0	$70,375	7.00%	0.415	$29,203
14	$0	$70,375	$0	$70,375	7.00%	0.388	$27,293
15	$0	$70,375	$50,000	$120,375	7.00%	0.362	$43,629
16	$0	$70,375	$0	$70,375	7.00%	0.339	$23,838
17	$0	$70,375	$0	$70,375	7.00%	0.317	$22,279
18	$0	$70,375	$0	$70,375	7.00%	0.296	$20,821
19	$0	$70,375	$0	$70,375	7.00%	0.277	$19,459
20	$0	$70,375	$50,000	$120,375	7.00%	0.258	$31,107
21	$0	$70,375	$0	$70,375	7.00%	0.242	$16,996
22	$0	$70,375	$0	$70,375	7.00%	0.226	$15,885
23	$0	$70,375	$0	$70,375	7.00%	0.211	$14,845
24	$0	$70,375	$0	$70,375	7.00%	0.197	$13,874
25	$0	$70,375	$50,000	$120,375	7.00%	0.184	$22,179
26	$0	$70,375	$0	$70,375	7.00%	0.172	$12,118
27	$0	$70,375	$0	$70,375	7.00%	0.161	$11,325
28	$0	$70,375	$0	$70,375	7.00%	0.150	$10,585
29	$0	$70,375	$0	$70,375	7.00%	0.141	$9,892
30	$0	$70,375	$50,000	$120,375	7.00%	0.131	$15,813
TOTAL	**$0**	**$2,252,000**	**$350,000**	**$2,658,672**			**$1,200,738**

TABLE HBHA-2-A
ALTERNATIVE HBHA-2 COST ASSUMPTIONS
MONITORING - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		RATIONALE
General Assumptions		
Alternative HBHA-2 would not take any actions to contain, remove, or treat contaminated sediment in the HBHA Pond. Alternative HBHA-2 would rely upon natural physical, chemical, and/or biological processes to reduce the bioavailability of contaminants in sediment, thereby reducing ecological risks due to contaminants in sediment. No capital costs would be incurred to implement this alternative.		
OM.1.0 Annual Operations and Maintenance Costs		
The O&M costs for Alternative HBHA-2 are assumed to consist of periodic costs to monitor contaminant concentrations in sediment at the bottom of the HBHA Pond (assume 10 samples per round). For the purposes of estimating the present worth of this alternative, quarterly sampling was assumed for Years 1 and 2 of the remedial action, and semi-annual sampling was assumed for years 3-30 of the remedial action. Costs in this section were calculated based on a quarterly sampling schedule. For years 3-30 (semi-annual sampling), annual O&M costs were assumed to be half of those calculated for the quarterly sampling schedule.		
Since under this alternative contamination would remain on-site above levels that allow for unlimited use and unrestricted exposure to sediment, five-year reviews would be required to periodically evaluate the protectiveness of the remedy.		
OM.1.1	Mobilize Sampling Equipment and Labor	Mobilize sediment sampling equipment, including watercraft at $400.
		Labor for sampling effort includes 3 workers, mobilize workers at $40/each.
		$520/event * 4 events/year = $2080.
OM.1.2	Sediment Sample Collection Labor	Assume three 10 HR days to collect and process sediment samples - 90 HR total @ $85/HR.
		90 HR/event * 4 events/YR = 360 HR.
OM.1.3	Sediment Sampling Equipment Rental	Sampling equipment rental (1 week) includes: watercraft, sampling apparatus, sample handling equipment, real-time air monitoring instrument.
OM.1.4	Sediment Sampling Supplies	Sampling supplies include consumable items such as PPE, sample shipping materials, sample bottleware, etc.
OM.1.5	Sediment Sample Analysis	Assume samples analyzed for metals @ $100/sample and SVOCs @ $250/sample.
OM.1.6	Data Validation	Tier I data validation, 80 HR @ $100/HR.
OM.1.7	Reporting	One data summary report per sampling round, $10,000 per report.

TABLE HBHA-3
ALTERNATIVE HBHA-3 CAPITAL COSTS
SUBAQUEOUS CAP - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0 Mobilization/Demobilization						
1.1	Equipment Mobilization	1	LS	$20,000	$20,000	[1]
1.2	Field Support Facilities	1	LS	$4,200	$4,200	[1]
1.3	Monthly Costs associated with Field Support	6	MONTH	$2,750	$16,500	[1]
	Subtotal				**$40,700**	
2.0 Site Preparation						
2.1	Clear and Grub	2	ACRE	$3,150	$6,300	Means 2004 HC, 02230 100 0020
2.2	Pond Bottom Survey	1	LS	$40,000	$40,000	[1]
2.3	Construct Equipment Decontamination Pad	2	EA	$7,500	$15,000	Means 2004 HC
2.4	Construct Material Staging Areas	2	EA	$2,500	$5,000	Means 2004 HC
2.5	Install Erosion and Sedimentation Controls	4,000	LF	$3.73	$14,920	Means 2004 HC, 02370 700 1250
2.6	Sheet Piling Cofferdam (drive, extract & salvage)	12,500	SF	$23.50	$293,750	Means 2004 HC, 02260 200 0060
2.7	Whalers and Connections	12,500	SF	$33.50	$418,750	Means 2004 HC, 02260 200 0500
2.8	Dewatering Pump Rentals	1	LS	$25,000.00	$25,000	Rain for Rent, 2005
2.9	Sand Filter Media	1	LS	$15,000.00	$15,000	Rain for Rent, 2005
2.10	System Installation Labor	1	LS	$2,500.00	$2,500	Rain for Rent, 2005
2.11	Operate System and Attend Pumps	90	DAY	$900.00	$81,000	Rain for Rent, 2005
	Subtotal				**$917,220**	
3.0 Placement of Subaqueous Cover						
3.1	Place Geotextile	191,000	SF	$2.75	$525,250	Means 2004 HC, 02340 300 1500
3.2	Sample Cap Material	24	EA	$1,000.00	$24,000	[1]
3.3	Backfill with Washed Sand (12 inches)	8,000	CY	$30.00	$240,000	[1]
3.4	Backfill with Wetland Substrate (6 inches)	4,000	CY	$53.90	$215,600	Means 2004 ER, 18 05 0301
3.5	Equipment Decontamination (for duration of construction)	700	HR	$39.56	$27,692	Means 2004 ER, 33 17 0823
	Subtotal				**$1,004,850**	
TOTAL DIRECT COSTS					**$1,962,770**	
4.0 Other Costs						
4.1	Project Management (6%)				$117,766	EPA OSWER 9355.0-75
4.2	Engineering and Design (12%)				$235,532	EPA OSWER 9355.0-75
4.3	Construction Management (8%)				$157,022	EPA OSWER 9355.0-75
4.4	Location Adustment (10%)				$196,277	Means 2004 ER
4.5	Contingency (25%)				$490,693	EPA OSWER 9355.0-75
TOTAL OTHER COSTS					**$1,197,290**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE HBHA-3					**$3,160,060**	

Notes:

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.

Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.

TABLE HBHA-3-OM
ALTERNATIVE HBHA-3 OPERATIONS AND MAINTENANCE COSTS
SUBAQUEOUS CAP - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual O&M Costs						
OM.1.1	Labor - Periodic Inspections (Quarterly)	64	HR	$200.00	$12,800	[1]
OM.1.2	Equipment Mobilization/Demobilization	4	EA	$5,000.00	$20,000	[1]
OM.1.3	Cap Maintenance (Assume 5% cap area per year)					
1.3.1	Topsoil, Furnished and Placed	600	CY	$53.90	$32,340	Means 2004 ER, 18 05 0301
1.3.2	Erosion controls/sampling	1	LS	$5,000.00	$5,000	Means 2004 ER, 18 05 0402
1.3.3	Maintenance Labor	240	HR	$85.00	$20,400	[1]
OM.1.4	Reporting (Annual)	1	LS	$20,000.00	$20,000	[1]
	Subtotal				**$110,540**	
TOTAL ANNUAL O&M COSTS					**$110,540**	
OM.2.0 Other O&M Costs						
OM.2.1	Project Management (10%)				$11,054	
OM.2.2	O&M Contingency (20%)				$22,108	
TOTAL OTHER O&M COSTS					**$33,162**	
ANNUAL O&M COSTS ALTERNATIVE HBHA-3					**$143,702**	

Notes:

Present worth analysis includes $50,000 every five years for five-year review.

Present worth analysis includes $40,000 dollars for bathymetric survey every other year.

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.

[1] Best estimate based on previous experience.

TABLE HBHA-3-PW
ALTERNATIVE HBHA-3 PRESENT WORTH ANALYSIS
SUBAQUEOUS CAP - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$3,160,060	$0	$0	$3,160,060	7.0%	1.000	$3,160,060
1	$0	$143,702	$0	$143,702	7.0%	0.935	$134,301
2	$0	$143,702	$40,000	$183,702	7.0%	0.873	$160,452
3	$0	$143,702	$0	$143,702	7.0%	0.816	$117,304
4	$0	$143,702	$40,000	$183,702	7.0%	0.763	$140,145
5	$0	$143,702	$50,000	$193,702	7.0%	0.713	$138,107
6	$0	$143,702	$40,000	$183,702	7.0%	0.666	$122,408
7	$0	$143,702	$0	$143,702	7.0%	0.623	$89,490
8	$0	$143,702	$40,000	$183,702	7.0%	0.582	$106,916
9	$0	$143,702	$0	$143,702	7.0%	0.544	$78,164
10	$0	$143,702	$90,000	$233,702	7.0%	0.508	$118,802
11	$0	$143,702	$0	$143,702	7.0%	0.475	$68,272
12	$0	$143,702	$40,000	$183,702	7.0%	0.444	$81,566
13	$0	$143,702	$0	$143,702	7.0%	0.415	$59,631
14	$0	$143,702	$40,000	$183,702	7.0%	0.388	$71,243
15	$0	$143,702	$50,000	$193,702	7.0%	0.362	$70,207
16	$0	$143,702	$40,000	$183,702	7.0%	0.339	$62,226
17	$0	$143,702	$0	$143,702	7.0%	0.317	$45,492
18	$0	$143,702	$40,000	$183,702	7.0%	0.296	$54,351
19	$0	$143,702	$0	$143,702	7.0%	0.277	$39,735
20	$0	$143,702	$90,000	$233,702	7.0%	0.258	$60,393
21	$0	$143,702	$0	$143,702	7.0%	0.242	$34,706
22	$0	$143,702	$40,000	$183,702	7.0%	0.226	$41,464
23	$0	$143,702	$0	$143,702	7.0%	0.211	$30,313
24	$0	$143,702	$40,000	$183,702	7.0%	0.197	$36,216
25	$0	$143,702	$50,000	$193,702	7.0%	0.184	$35,689
26	$0	$143,702	$40,000	$183,702	7.0%	0.172	$31,633
27	$0	$143,702	$0	$143,702	7.0%	0.161	$23,126
28	$0	$143,702	$40,000	$183,702	7.0%	0.150	$27,629
29	$0	$143,702	$0	$143,702	7.0%	0.141	$20,199
30	$0	$143,702	$90,000	$233,702	7.0%	0.131	$30,701
TOTAL	**$3,160,060**	**$4,311,060**	**$900,000**	**$8,371,120**			**$5,290,943**

TABLE HBHA-3-A
ALTERNATIVE HBHA-3 COST ASSUMPTIONS
SUBAQUEOUS CAP - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	BASIS OF COST
	CAPITAL COSTS (TABLE HBHA-3)	
General Assumptions		
	Alternative HBHA-3 includes the placement of a subaqueous cap over contaminated sediments in the HBHA Pond. For the purposes of estimating capital costs to implement this alternative, the subaqueous cap was assumed to consist of 12 inches of sand overlain by 6 inches of organic-rich soil that would provide a substrat for the redevelopment of benthic communities at the base of the Pond. The 18-inch total cap thickness was assumed to be adequate to resist bioturbation and physical stressed from water currents so that ecological exposures to contaminated sediment would be prevented.	
	For the purposes of developing this cost estimate, it was assumed that the HBHA Pond would be dewatered and cap materials would be placed directly onto the dry pond bottom.	
1.0 Mobilization/Demobilization		
1.1	Equipment mobilization	Assume less than 50 mile haul distance for all equipment.
		Equipment would be mobilized and demobilized to and from the site once for this project.
		Assume $500 for mob, $500 for demob per piece of equipment.
		Unit costs include labor cost for equipment mob/demob.
1.2	Field Support Facilities	Field support facilities will be mobilized and demobilized to and from the central field support area once during the course of the project.
		The following items are included in this cost line item: office trailer @ $500, storage trailer @ $500, dumpster @ $100, sanitary facilities @ $100, PPE @ $3000.
1.3	Monthly Costs associated with Field Support	Includes monthly rental costs for duration of project for the following: office trailer @ $400, storage trailer @ $200, utilities @ $200, dumpster @ $200, sampling materials @ $1000, air sampling equipment (PID) @ 750.
2.0 Site Preparation		
	Site preparation that was assumed to be necessary prior to construction activities included clearing and grubbing at certain locations around the perimeter of the Pond, a bathymetric survey to establish the existing contours of the Pond bottom, the construction of decontamination facilities in the material staging areas, construction of a stockpiling area for the cap materials that would be dumped at the site, and the installation of erosion and sedimentation controls in the areas where construction activities might cause excessive erosion of soils into the Pond or another surface water body in the vicinity of the Pond.	
2.1	Clear and Grub	Assume clear and grub of approximately 2 acres at various points around perimeter of HBHA Pond
		Cut & chip light trees to 6" diameter.
		Crew B-7: 1 labor foreman, 4 laborers, 1 equipment operator.
		1 chipping machine, 1 front-end loader, 2 chainsaws
2.2	Pond Bottom Survey	Assume $40,000 for bathymetric survey to determine current Pond bottom contours for comparison with post-construction contours. Cost estimate based on value published in EPA-905-B94-003 (ARCS Remediation Guidance Document).
2.3	Construct Decontamination Pads	Assumes construction of heavy equipment decontamination pads at two locations within construction area.
		Assumptions for decontamination pad construction presented on Table SS-3-A.
2.4	Construct Material Staging Areas	Assume two material staging areas to be constructed within construction zone to provide temporary storage for soil that is used to construct the cap.
		Assumptions for staging areas presented on Table SS-3-A.
2.5	Install Erosion and Sedimentation Controls	Erosion and sedimentation controls would be installed at the perimeter of all work areas where erosion and sedimentation may impact sensitive environmental areas such as wetlands, surface water bodies, etc.
2.6	Sheet Piling Cofferdam	Cost to drive, extract, and salvage sheet piling (barge-driven) to construct cofferdam.
		Crew B-40: 1 pile driver foreman, 4 pile drivers, 2 equipment operators (crane), 1 equipment operator (oiler), 1 crane (40 ton), 1 vibratory hammer. Daily rate = $6,000.
2.7	Whalers and Connections	Soldier beams and lagging H-piles with 3" wood sheeting horizontal between piles. Cost includes removal of wales and braces.
		Crew B-50: 2 pile driver foremen, 6 pile drivers, 2 equipment operators (crane), 1 equipment operator (oiler), 3 laborers, 1 crane (40 ton), 60 LF leads - 15K ft lbs, 1 hammer - 15K ft lbs, 1 air compressor (600 CFM), 2-50 ft air hoses. Daily rate = $7,500.
3.0 Placement of Subaqueous Cap		
3.1	Place Geotextile	Placement of geotextile along pond bottom; 191,000 SF (see Figure 2-5a)
		Crew CODET: 1 laborer, 1 hydraulic excavator, 2.00 CY bucket, 1 equipment operator. Labor costs included in unit cost.
		191,000 SF / 22,500 SF/DAY ≈ 9 DAYS.
3.2	Sample Cap Materials	Soil samples will be collected from cap materials to verify their suitability for use as subaqueous cap a a rate of one sample per 500 CY.
3.3	Backfill with Washed Sand	Assume 1 foot of washed sand to be placed over geotextile. $30 to furnish and place sand
		Crew B-34D (5): 1 truck driver, 1 truck tractor 40 ton, 1 dump trailer 20 CY.
		8,000 CY * 1 HR/50 CY ≈ 160 HR.
3.4	Backfill with Wetland Substrate	Placement of topsoil (6") over washed sand. 11.5 CY/HR.
		Crew CODLA: 1 equipment operator, 1 semi-skilled laborer. Daily rate = $650
		4,000 CY * 1 HR/11.5 CY ≈ 350 HR.
3.5	Equipment Decontamination	Assume decontamination of heavy vehicles as they leave construction area. Operate 1,800 PSI pressure washer at $39.56/HR. Includes water, soap, electricity, and labor. Assume operation during entire duration of cap placement activities.

TABLE HBHA-3-A
ALTERNATIVE HBHA-3 COST ASSUMPTIONS
SUBAQUEOUS CAP - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		BASIS OF COST
OPERATIONS AND MAINTENANCE COSTS (TABLE HBHA-3-OM)		
OM.1.0 Annual O&M Costs		
OM.1.1	Labor - Periodic Inspections (Quarterly)	Assume 16 HR per quarter to inspect cap @ $200/HR.
OM.1.2	Equipment Mobilization/Demobilization	Mob/demob repair and maintenance equipment.
OM.1.3	Cap Maintenance	Cap maintenance assumed to require 5% replacement of cap volume per year.
OM.1.4	Reporting (Annual)	Annual maintenance report at $20,000.

TABLE HBHA-4
ALTERNATIVE HBHA-4 CAPITAL COSTS
STORMWATER BYPASS AND SEDIMENT RETENTION WITH PARTIAL DREDGING
AND PROVIDING AN ALTERNATE HABITAT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0 Mobilization/Demobilization						
1.1	Equipment Mobilization	1	LS	$24,000	$24,000	[1]
1.2	Field Support Facilities	1	LS	$3,200	$3,200	[1]
1.3	Monthly Costs associated with Field Support	6	MONTH	$2,750	$16,500	[1]
	Subtotal				**$43,700**	
2.0 Site Preparation						
2.1	Site Access Road Construction	1,500	SY	$12.55	$18,825	Means 2004 HC, 02720 200 0300
2.2	Clear and Grub	1	ACRE	$3,150	$3,150	Means 2004 HC, 02230 100 0020
2.3	Construct Equipment Decontamination Pads	3	EA	$7,500	$22,500	Means 2004 HC
2.4	Construct Stockpiling Areas	3	EA	$2,500	$7,500	Means 2004 HC
2.5	Construct Dewatering Pads	6	EA	$2,500	$15,000	Means 2004 HC
2.6	Install Erosion and Sedimentation Controls	4,000	LF	$3.73	$14,920	Means 2004 HC, 02370 700 1250
	Subtotal				**$81,895**	
3.0 Dredge HBHA Pond Sediments						
3.1	Hydraulic Dredging, Pump to Shore	65	DAY	$9,900.00	$643,500	Mineral Processing Services LLC
3.2	Dewater Sediments, Treat effluent	3	MONTH	$45,000.00	$135,000	Mineral Processing Services LLC
3.3	Mob/Demob, utilities	3	MONTH	$10,000.00	$30,000	Mineral Processing Services LLC
	Subtotal				**$808,500**	
4.0 Transportation and Off-Site Disposal of Sediment						
4.1	Load Waste into Trucks (est. 20% solids, in-place volume)	1,340	CY	$2.29	$3,069	Means 2004 ER, 17 03 0277
4.2	Equipment Decontamination	520	HR	$39.56	$20,571	Means 2004 ER, 33 17 0823
4.3	Transportation of Contaminated Sediment	2,010	TON	$90.00	$180,900	Boston Environmental, 2005
4.4	Off-Site Disposal of Sediment (HW Landfill)	2,010	TON	$240.00	$482,400	Boston Environmental, 2005
	Subtotal				**$686,940**	
5.0 Stormwater Bypass/Sediment Retention Construction						
5.1	Spillway Construction (Stormwater Bypass)	1	LS	$50,000	$50,000	[1]
5.2	Sediment Retention System					
5.2.1	*Sheet Piling, left in place*	4,500	SF	$25.00	$112,500	Means HC 2004, 02260 200 0700
5.2.2	*Coffer Dam with 14" Soldier Beams/Whalers*	4,500	SF	$40.00	$180,000	Means HC 2004, 02260 200 0700
5.3	Surface Water Polishing Cell					
5.3.1	*Sheet Piling, left in place*	4,500	SF	$25.00	$112,500	Means HC 2004, 02260 200 0700
5.3.2	*Coffer Dam with 14" Soldier Beams/Whalers*	4,500	SF	$40.00	$180,000	Means HC 2004, 02260 200 0700
5.3.3	*Diffusion Aerator*	1	LS	$20,000.00	$20,000	[1]
	Subtotal				**$655,000**	
6.0 East Drainage Ditch Liner						
6.1	Equipment/Labor Costs	20	DAY	$5,000	$100,000	[1]
6.2	Erosion and Sedimentation Controls	1000	LF	$2.08	$2,080	02370 700 1250
6.3	Excavate for Subgrade Preparation	150	CY	$2.18	$327	Means 2004 HC, 02315 424 0200
6.4	Off-Site Transportation/Disposal of Excavated Soil	225	TON	$330.00	$74,250	Boston Environmental, 2005
6.5	Place 3/4-inch Stone	200	TON	$23.50	$4,700	Benevento, 2005
6.6	Line Trench with HDPE liner 60 mil	16,000	SF	$2.03	$32,480	Means, 2004 ER 33-08-0572-02081
6.7	Dewatering/Pump Around and Treatment Costs	20	DAY	$2,000.00	$40,000	Maverick, 2005
6.8	Line Channel with 4-6 inch stone	400	CY	$20.00	$8,000	Benevento, 2005
6.9	Place Topsoil	50	CY	$21.53	$1,076	Means HC, 02910 810 0400
6.10	Vegetation/Seeding	6000	SF	$0.14	$840	Maverick, 2005
	Subtotal				**$263,753**	
7.0 Permanent Erosion Control - Northern Shore of Pond						
7.1	Equipment/Labor Costs	10	DAY	$3,000	$30,000	[1]
7.2	Clear and Grub	7500	SF	$0.17	$1,275	Means 2004 HC, 02230 100 0020
7.3	Place Geotextile	5000	SF	$0.26	$1,300	Means 2004 HC, 02340 300 1500
7.4	Place 18" Soil Cover	275	CY	$9.98	$2,743	[1]
7.5	Vegetation/Seeding	5000	SF	$0.14	$700	Maverick, 2005
	Subtotal				**$36,018**	
8.0 Provide Alternate Habitat (~1 acre)						
8.1	Property Acquisition	1	ACRE	$700,000	$700,000	[1]
8.2	Site Prep/ Equipment Mob/Demob/ Layout	1	LS	15,000.00	$15,000	[1]
8.3	Excavate wetland (estimate 4 foot average)	8,200	CY	1.68	$13,776	Means 2004 HC, 02300 424 0260

TABLE HBHA-4
ALTERNATIVE HBHA-4 CAPITAL COSTS
STORMWATER BYPASS AND SEDIMENT RETENTION WITH PARTIAL DREDGING
AND PROVIDING AN ALTERNATE HABITAT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
8.0 Provide Alternate Habitat (continued)						
8.4	Haul to stockpile area	10,250	CY	2.94	$30,135	Means 2004 HC, 02315 490 0310
8.5	Load for offiste disposal	10,250	CY	1.35	$13,838	Means 2004 HC, 02300 424 1300
8.6	Stockpile Management	1	LS	5,000.00	$5,000	[1]
8.7	Analyze/Test Fill and Topsoil (1 per 500 CY fill)	4	EA	$500.00	$2,000	[1]
8.8	Import, Place, and Grade Topsoil w/ Minimal Compaction	2,000	CY	$34.85	$69,700	Means 2004 HC, 02910 810 0500
8.9	Import and Install Coir Logs	150	EA	$500.00	$75,000	[1]
8.10	Import and Install Coir Fiber Mats	6,000	SY	$2.00	$12,000	[1]
8.11	Establish Ground Cover	55	MSF	$2,500.00	$137,500	[1]
8.12	Plantings	55	MSF	$2,000.00	$110,000	[1]
8.13	Mulching	55	MSF	$61.55	$3,385	Means 2004 HC, 02910 500 0250
	Subtotal				**$1,187,334**	
TOTAL DIRECT COSTS					**$3,763,140**	
9.0 Other Costs						
9.1	Project Management (5%)				$188,157	OSWER 9355.0-75
9.2	Engineering and Design (8%)				$301,051	OSWER 9355.0-75
9.3	Construction Management (6%)				$225,788	OSWER 9355.0-75
9.4	Location Adustment (10%)				$376,314	Means 2004 ER
9.5	Contingency (15%)				$564,471	OSWER 9355.0-75
TOTAL OTHER COSTS					**$1,655,782**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE HBHA-4					**$5,418,921**	

Notes:
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE HBHA-4-OM
ALTERNATIVE HBHA-4 OPERATIONS AND MAINTENANCE COSTS
STORMWATER BYPASS AND SEDIMENT RETENTION WITH PARTIAL DREDGING
AND PROVIDING AN ALTERNATE HABITAT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0	**Annual Monitoring Costs (assume quarterly)**					
OM.1.1	Periodic Inspections (Quarterly)	80	HR	$100.00	$8,000	[1]
OM.1.2	Sediment Sample Collection Labor	320	HR	$85.00	$27,200	[1]
OM.1.3	Sediment Sample Analysis (assume 20/quarter)					
1.3.1	*Metals (Arsenic)*	80	EA	$100.00	$8,000	[1]
1.3.2	*SVOCs*	80	EA	$250.00	$20,000	[1]
OM.1.4	Data Validation	4	EA	$10,000.00	$40,000	[1]
OM.1.5	Reporting	4	EA	$5,000.00	$20,000	[1]
	Subtotal				**$123,200**	
OM.2.0	**Maintenance of Equipment (aerator, silt curtains, etc.)**					
OM.2.1	Annual Maintenance	1	LS	$20,000.00	$20,000	[1]
	Subtotal				**$20,000**	
TOTAL ANNUAL MONITORING COSTS (Years 1-3) - quarterly monitoring					**$123,200**	
TOTAL ANNUAL MONITORING COSTS (Years 4-30) - semi-annual monitoring					**$61,600**	
TOTAL ANNUAL MAINTENANCE COSTS (Years 1-30)					**$20,000**	
OM.2.0a	**Other O&M Costs (Years 1-3)**					
OM.2.1a	Project Management (8%)				$11,456	OSWER 9355.0-75
OM.2.2a	O&M Contingency (15%)				$21,480	OSWER 9355.0-75
	Subtotal				**$32,936**	
OM.2.0b	**Other O&M Costs (Years 4-30)**					
OM.2.1b	Project Management (8%)				$6,528	OSWER 9355.0-75
OM.2.2b	O&M Contingency (15%)				$12,240	OSWER 9355.0-75
	Subtotal				**$18,768**	
ANNUAL O&M COSTS (YEARS 1-3) ALTERNATIVE HBHA-4					**$176,136**	
ANNUAL O&M COSTS (YEARS 4-30) ALTERNATIVE HBHA-4					**$100,368**	

Notes:

Present worth analysis includes periodic cost of $50,000 for preparation of five-year review.

Present worth analysis assumes the costs in this table would be incurred for years 1-3 of the O&M period. In years 4-30, semi-annual monitoring/sampling was assumed.

[1] Best estimate based on previous experience.

TABLE HBHA-4-P
ALTERNATIVE HBHA-4 PERIODIC COSTS
STORMWATER BYPASS AND SEDIMENT RETENTION WITH PARTIAL DREDGING
AND PROVIDING AN ALTERNATE HABITAT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0 Mobilization/Demobilization						
1.1	Equipment Mobilization	1	LS	$24,000	$24,000	[1]
1.2	Field Support Facilities	1	LS	$3,200	$3,200	[1]
1.3	Monthly Costs associated with Field Support	1	MONTH	$2,750	$2,750	[1]
	Subtotal				**$29,950**	
2.0 Site Preparation						
2.1	Install Erosion and Sedimentation Controls	2,000	LF	$3.73	$7,460	Means 2004 ER
	Subtotal				**$7,460**	
3.0 Dredge HBHA Pond Sediments						
3.1	Hydraulic Dredging, Pump to Shore	20	DAY	$9,900.00	$198,000	Mineral Processing Services LLC
3.2	Dewater Sediments, Treat effluent	1	MONTH	$45,000.00	$45,000	Mineral Processing Services LLC
3.3	Mob/Demob, utilities	1	MONTH	$10,000.00	$10,000	Mineral Processing Services LLC
	Subtotal				**$253,000**	
4.0 Transportation and Off-Site Disposal of Sediment						
4.1	Load Waste into Trucks	900	CY	$2.29	$2,061	Means 2004 ER, 17 03 0277
4.2	Equipment Decontamination	23	HR	$39.56	$890	Means 2004 ER, 33 17 0823
4.3	Transportation of Contaminated Sediment	1,350	TON	$90.00	$121,500	Boston Environmental, 2005
4.4	Off-Site Disposal of Sediment (HW Landfill)	1,350	TON	$240.00	$324,000	Boston Environmental, 2005
	Subtotal				**$448,451**	
TOTAL DIRECT COSTS					**$738,861**	
5.0 Other Costs						
5.1	Project Management (5%)				$36,943	OSWER 9355.0-75
5.2	Engineering and Design (8%)				$59,109	OSWER 9355.0-75
5.3	Construction Management (6%)				$44,332	OSWER 9355.0-75
5.4	Location Adustment (10%)				$73,886	Means 2004 ER
5.5	Contingency (10%)				$73,886	OSWER 9355.0-75
TOTAL OTHER COSTS					**$288,156**	
TOTAL COST FOR PERIODIC DREDGING - ALTERNATIVE HBHA-4					**$1,027,017**	

Notes:

TABLE HBHA-4-PW
ALTERNATIVE HBHA-4 PRESENT WORTH ANALYSIS
STORMWATER BYPASS AND SEDIMENT RETENTION WITH PARTIAL DREDGING
AND PROVIDING AN ALTERNATE HABITAT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$5,418,921	0	$0	$5,418,921	7.0%	1.000	$5,418,921
1	$0	$176,136	$0	$176,136	7.0%	0.935	$164,613
2	$0	$176,136	$0	$176,136	7.0%	0.873	$153,844
3	$0	$176,136	$0	$176,136	7.0%	0.816	$143,779
4	$0	$100,368	$0	$100,368	7.0%	0.763	$76,570
5	$0	$100,368	$1,077,017	$1,177,385	7.0%	0.713	$839,459
6	$0	$100,368	$0	$100,368	7.0%	0.666	$66,879
7	$0	$100,368	$0	$100,368	7.0%	0.623	$62,504
8	$0	$100,368	$0	$100,368	7.0%	0.582	$58,415
9	$0	$100,368	$0	$100,368	7.0%	0.544	$54,594
10	$0	$100,368	$1,077,017	$1,177,385	7.0%	0.508	$598,523
11	$0	$100,368	$0	$100,368	7.0%	0.475	$47,684
12	$0	$100,368	$0	$100,368	7.0%	0.444	$44,565
13	$0	$100,368	$0	$100,368	7.0%	0.415	$41,649
14	$0	$100,368	$0	$100,368	7.0%	0.388	$38,924
15	$0	$100,368	$1,077,017	$1,177,385	7.0%	0.362	$426,738
16	$0	$100,368	$0	$100,368	7.0%	0.339	$33,998
17	$0	$100,368	$0	$100,368	7.0%	0.317	$31,774
18	$0	$100,368	$0	$100,368	7.0%	0.296	$29,695
19	$0	$100,368	$0	$100,368	7.0%	0.277	$27,753
20	$0	$100,368	$1,077,017	$1,177,385	7.0%	0.258	$304,259
21	$0	$100,368	$0	$100,368	7.0%	0.242	$24,240
22	$0	$100,368	$0	$100,368	7.0%	0.226	$22,654
23	$0	$100,368	$0	$100,368	7.0%	0.211	$21,172
24	$0	$100,368	$0	$100,368	7.0%	0.197	$19,787
25	$0	$100,368	$1,077,017	$1,177,385	7.0%	0.184	$216,932
26	$0	$100,368	$0	$100,368	7.0%	0.172	$17,283
27	$0	$100,368	$0	$100,368	7.0%	0.161	$16,152
28	$0	$100,368	$0	$100,368	7.0%	0.150	$15,096
29	$0	$100,368	$0	$100,368	7.0%	0.141	$14,108
30	$0	$100,368	$1,077,017	$1,177,385	7.0%	0.131	$154,670
TOTAL	**$5,418,921**	**$3,238,344**	**$6,462,102**	**$15,119,367**			**$9,187,237**

TABLE HBHA-4-A
ALTERNATIVE HBHA-4 COST ASSUMPTIONS
STORMWATER BYPASS AND SEDIMENT RETENTION WITH PARTIAL DREDGING
AND PROVIDING AN ALTERNATE HABITAT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	RATIONALE
General Assumptions		
	Alternative HBHA-4 is a sediment remediation alternative that includes partial dredging of the HBHA Pond (see Figure 4-3) using hydraulic dredging techniques. Dredged material would be dewatered and transported to an off-site disposal facility. For the purpose of estimating costs for the feasibility study. It was assumed that dewatered sediment would be characterized as hazardous waste based on the concentration of arsenic present, and would require disposal at a RCRA hazardous waste landfill.	
	Under this alternative, the portions of the HBHA Pond that are not dredged would be isolated from the remainder of the Pond by a low-head coffer dam constructed using sheet piling; and a series of surface water flow controls would be constructed in the contaminated portion of the Pond with the goal of preventing storm flow conditions. A stormwater bypass would be constructed where Halls Brook discharges to the Pond and surface water flow mitigation structures would be constructed to promote sedimentation within the contaminated areas of the Pond.	
1.0 Mobilization/Demobilization		
	One work week (5 days) assumed for mobilization of labor and equipment for this alternative.	
1.1	Equipment mobilization	Assume less than 50 mile haul distance for all equipment.
		Equipment would be mobilized and demobilized to and from the site once for this project.
		Unit costs include labor cost for equipment mob/demob.
1.2	Field Support Facilities	Field support facilities will be mobilized and demobilized to and from the central field support area once during the course of the project.
		The following items are included in this cost line item: office trailer @ $500, storage trailer @ $500, dumpster @ $100, sanitary facilities @ $100, soil sampling equipment @ $2000.
1.3	Monthly Costs associated with Field Support	Includes monthly rental costs for duration of project for the following: office trailer @ $400, storage trailer @ $200, utilities @ $200, dumpster @ $200, sampling materials @ $1000, air sampling equipment (PID) @ 750.
2.0 Site Preparation		
	Site preparation assumptions are similar to those presented on Table NS-4-A for Alternative NS-4. Quantities have been adjusted accordingly to account for the differences in site conditions in the HBHA Pond area versus the remediation areas that are impacted by Alternative NS-4.	
3.0 Dredge HBHA Pond Sediments		
	Under this alternative, sediments would be dredged from an area of the HBHA Pond encompassing approximately 135,000 SF. The assumed thickness of contaminated sediments in the Pond was 16 inches. 135,000 SF * 1.33 LF = 180,000 CF≈ 6,700 CY in place.	
	The cost estimates and remedial time frames that are presented in the cost estimate for hydraulic dredging in the HBHA Pond are based on discussions with a dredging contractor with experience performing dredging projects similar to those proposed for this alternative.	
4.0 Transportation and Off-Site Disposal Sediment		
	The sediment that would be dredged from the HBHA Pond was assumed to contain approximately 20 percent solids. This estimate was based on observations made during sediment investigations in the Pond during the Remedial Investigation. For the purposes of estimating disposal quantities for the cost estimate, it wa therefore assumed that 6,700 CY of sediment (in place), as estimated above, would translate to approximately 1,340 CY of solids that would require off-site disposal.	
	For the purpose of estimating off-site disposal requirements, 1 CY of solids was assumed to weigh 1.5 tons, resulting in 2,010 tons of solids to be loaded into trucks and transported to the off-site landfill facility. Decontamination of heavy equipment would be performed for the duration of transportation and disposal activities to prevent the transport of contaminated material onto public or private roadways adjacent to the work site.	
	The cost estimates for transportation and disposal of contaminated sediment are based on a quote from a disposal contractor, assuming that the sediment that is dredged from the Pond is characterized as hazardous based on the concentrations of arsenic present. Waste characterization samples would be collected from stockpiled sediments to verify this assumption. Costs for the collection and analysis of waste characterization samples are included in the disposal cost estimate.	
5.0 Stormwater Bypass/Sediment Retention Construction		
	The stormwater bypass (spillway) that would be constructed as part of Alternative HBHA-4 would consist of a concrete structure as depicted on Figure 4-x. The cost estimate provided for construction and installation of the structure is based on an estimate of labor and material costs associated with the construction of similar types of concrete structures.	
	Sheet piling would be used to construct the low-head coffer dam used to separate the dredged portions of the Pond from the contaminated portion of the Pond. This sheet piling would be driven from a barge situated on the Pond. The estimated costs to construct the sheet pile coffer dam are based on published unit costs for sheet pile installation.	
	A portion of the dredged area of the HBHA Pond (located immediately to the south of the sediment retention area) would be isolated from the southernmost area o the Pond by a second coffer dam, constructed in a similar manner to the northern coffer dam. This area would be utilized as a secondary treatment area to polish the effluent from the sediment retention area prior to discharge into the HBHA Pond. This secondary treatment area would include a diffusion aerator at the base the Pond to provide a continuing source of oxygen to surface water in the Pond so that residual arsenic or benzene contamination that remains in surface water as it leaves the sediment retention area can be treated prior to entering the HBHA Pond and Halls Brook Holding Area. The cost assumptions for the construction of this area assumes a coffer dam built in the same manner as the northern coffer dam, and installation of an aerator at the Pond bottom (including construction/installation of utilities required to operate the aerator).	
6.0 East Drainage Ditch Liner		
	Under this alternative, the east drainage ditch, which provides a surface water input to the Pond, would be stabilized to prevent the transport of contaminated sediment into the Pond. The stabilization of the ditch would include excavation of surface soil in the ditch, placement of an impermeable liner, and placing clean backfill material over the liner.	
6.1	Equipment/Labor Costs	Equipment and labor costs to perform the work are based on actual costs that were incurred to perform a similar project at another location on the site.
6.2	Erosion and Sedimentation Controls	Erosion and sedimentation controls (hay bales and silt fence) would be installed at the perimeter of th work area, on either side of the portion of the east drainage ditch that is being stabilized.
6.3	Excavate for Subgrade Preparation	In order to prepare the ditch for the liner and backfill material, approximately 3 inches of soil would be stripped from the surface, stockpiled, and transported for off-site disposal.

TABLE HBHA-4-A
ALTERNATIVE HBHA-4 COST ASSUMPTIONS
STORMWATER BYPASS AND SEDIMENT RETENTION WITH PARTIAL DREDGING
AND PROVIDING AN ALTERNATE HABITAT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	RATIONALE
6.0 East Drainage Ditch Liner (continued)		
6.4	Off-Site Transportation/Disposal of Excavated Soil	Off-site transportation and disposal costs are based on a vendor quote for disposal of soil as a RCRA hazardous waste. The assumption that excavated soil would be classified as hazardous was based on the concentrations of arsenic that are present. The actual hazardous/non-hazardous classification will be determined from the collection of waste characterization soil samples from stockpiled soil.
6.5	Place 3/4-inch Stone	3/4-inch stone would be placed at the base of the excavated ditch. Equipment and labor costs are included in line item 6.1. This line item includes the cost to deliver materials to the work site.
6.6	Line Trench with HDPE liner 60 mil	The ditch would be lined with a 60 mil impermeable HDPE liner. Unit cost based on R.S. Means Environmental Unit Cost value.
6.7	Dewatering/Pump Around and Treatment Costs	During performance of the work, water flowing through the drainage ditch would be diverted around the work area using a pump around system. Water that is pumped around the ditch would be treated to remove any contaminants or suspended solids. The price for this system is based on actual costs to perform a pump-around with treatment for another project on the Industri-Plex site.
6.8	Line Channel with 4-6 inch stone	The newly stabilized channel would be lined with 4 to 6 inch stone to provide permanent erosion control. The labor and equipment costs to perform this work are included in line item 6.1 This line item includes the cost to purchase and deliver the materials.
6.9	Place Topsoil	Backfill ditch with topsoil with FE loader. Crew B-10S: 1 equipment operator, 0.5 laborer, 1 FE loader Daily rate = $850.
6.10	Vegetation/Seeding	Vegetate ditch for erosion control. Costs provided by contractor, based on actual costs incurred at another project on the site.
7.0 Permanent Erosion Control - Northern Shore of Pond		
In order to prevent erosion of soil from the northern shore of the Pond, soils would be stabilized by placing an 18" soil cover underlain by a geotextile. The soil cover would be vegetated to prevent erosion of the cover into the HBHA Pond.		
7.1	Equipment/Labor Costs	Equipment and labor costs to perform the work are based on actual costs that were incurred to perform a similar project at another location on the site.
7.2	Clear and Grub	Cut and chip light trees to 6" diameter.
		Crew B-7: 1 labor foreman, 4 laborers, 1 equipment operator, 1 chipping machine, 1 FE loader, 2 chain saws. Daily rate = $3,200.
7.3	Place Geotextile	Geotextile fabric, woven, 200 lb tensile strength, placed along the north shore of the Pond.
7.4	Place 18" Soil Cover	18" soil cover placed over geotextile and lightly compacted.
7.5	Vegetation/Seeding	Vegetate ditch for erosion control. Costs provided by contractor, based on actual costs incurred at another project on the site.
8.0 Provide Alternate Habitat		
The costs to provide an alternate habitat were included in the estimate for Alternative HBHA-4 since no measures would be taken to remediate or remove the continuing source of contamination to surface water that is impacting ecological receptors in the northern portion of the HBHA Pond.		
The area for which compensatory wetlands would need to be constructed in order to provide the alternate habitat is estimated to be 55,000 square feet. This area includes the impacted area of the HBHA Pond (sediment retention area and secondary treatment area) and the impacted portions of the New Boston Street Drainway (600 feet x 5 feet wide). The assumptions and basis of cost that are presented in this estimate are the same as described for Alternative SW-3, which also involves the creation of a compensatory wetland.		
OPERATIONS AND MAINTENANCE COSTS (TABLE HBHA-4-OM)		
OM.1.0 Annual O&M Costs		
OM.1.1	Periodic Inspections (Quarterly)	Assume 20 HR per inspection, quarterly inspections.
OM.1.2	Sediment Sample Collection Labor	Assume 80 HR sampler labor to collect quarterly sediment samples.
OM.1.3	Sediment Sample Analysis	Assume 20 samples per event (quarterly sampling) analyzed for metals (arsenic) and SVOCs. Analytical costs based on actual costs to analyze samples for these parameters.
OM.1.4	Data Validation	Data validation quarterly at $10,000 per sampling event. Based on previous costs.
OM.1.5	Reporting	Data report preparation quarterly at $5,000 per event.

Note:

Present worth analysis includes periodic dredging costs in the northern portion of the Pond to remove contaminated sediment that accumulates in the Pond. The costs to perform this dredging operation are based on discussions with a dredging contractor with experience performing dredging projects similar to the once required to implement this alternative. Further detail on the assumptions and basis of cost for this work in provided on Table HBHA-5-A under the assumptions for Alternative HBHA-5 (Removal and Off-Site Disposal).

TABLE HBHA-5
ALTERNATIVE HBHA-5 CAPITAL COSTS
REMOVAL AND OFF-SITE DISPOSAL - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0	**Mobilization/Demobilization**					
1.1	Equipment Mobilization	1	LS	$24,000	$24,000	[1]
1.2	Field Support Facilities	1	LS	$3,200	$3,200	[1]
1.3	Monthly Costs associated with Field Support	6	MONTH	$4,000	$24,000	[1]
	Subtotal				**$51,200**	
2.0	**Site Preparation**					
2.1	Site Access Road Construction	2,500	SY	$12.55	$31,375	Means 2004 HC, 02720 200 0300
2.2	Clear and Grub	1	ACRE	$3,150	$3,150	Means 2004 HC, 02230 100 0020
2.3	Construct Equipment Decontamination Pads	3	EA	$7,500	$22,500	Means 2004 HC
2.4	Construct Stockpiling Area	1	LS	$2,500	$2,500	Means 2004 HC
2.5	Construct Stockpiling Areas	3	EA	$2,500	$7,500	Means 2004 HC
2.6	Construct Dewatering Pads	6	EA	$2,500	$15,000	Means 2004 HC
2.7	Install Erosion and Sedimentation Controls	2,000	LF	$3.73	$7,460	Means 2004 HC, 02370 700 1250
	Subtotal				**$89,485**	
3.0	**Dredge HBHA Pond Sediments**					
3.1	Hydraulic Dredging, Pump to Shore	80	DY	$9,900.00	$792,000	Mineral Processing Services LLC
3.2	Dewater Sediments, Treat effluent	4	MONTH	$45,000.00	$180,000	Mineral Processing Services LLC
3.3	Mob/Demob, utilities,	4	MONTH	$10,000.00	$40,000	Mineral Processing Services LLC
	Subtotal				**$1,012,000**	
4.0	**Transportation and Off-Site Disposal of Sediment**					
4.1	Load Waste into Trucks	1,880	CY	$2.29	$4,305	Means 2004 ER, 17 03 0277
4.2	Equipment Decontamination	47	HR	$39.56	$1,859	Means 2004 ER, 33 17 0823
4.3	Transportation of Contaminated Sediment	2,820	TON	$90.00	$253,800	Boston Environmental, 2005
4.4	Off-Site Disposal of Sediment (HW Landfill)	2,820	TON	$240.00	$676,800	Boston Environmental, 2005
	Subtotal				**$936,765**	
5.0	**East Drainage Ditch Liner**					
5.1	Equipment/Labor Costs	20	DAY	$5,000	$100,000	[1]
5.2	Erosion and Sedimentation Controls	1000	LF	$2.08	$2,080	02370 700 1250
5.3	Excavate for Subgrade Preparation	150	CY	$2.18	$327	Means 2004 HC, 02315 424 0200
5.4	Off-Site Transportation/Disposal of Excavated Soil	225	TON	$330.00	$74,250	Boston Environmental, 2005
5.5	Place 3/4-inch Stone	200	TON	$23.50	$4,700	Benevento, 2005
5.6	Line Trench with HDPE liner 60 mil	16,000	SF	$2.03	$32,480	Means, 2004 ER 33-08-0572-02081
5.7	Dewatering/Pump Around and Treatment Costs	20	DAY	$2,000.00	$40,000	Maverick, 2005
5.8	Line Channel with 4-6 inch stone	400	CY	$20.00	$8,000	Benevento, 2005
5.9	Place Topsoil	50	CY	$21.53	$1,076	Means HC, 02910 810 0400
5.10	Vegetation/Seeding	6000	SF	$0.14	$840	Maverick, 2005
	Subtotal				**$263,753**	
6.0	**Permanent Erosion Control - Northern Shore of Pond**					
6.1	Equipment/Labor Costs	10	DAY	$3,000	$30,000	[1]
6.2	Clear and Grub	7500	SF	$0.17	$1,275	Means 2004 HC, 02230 100 0020
6.3	Place Geotextile	5000	SF	$0.26	$1,300	Means 2004 HC, 02340 300 1500
6.4	Place 18" Soil Cover	275	CY	$9.98	$2,743	[1]
6.5	Vegetation/Seeding	5000	SF	$0.14	$700	Maverick, 2005
	Subtotal				**$36,018**	
	TOTAL DIRECT COSTS				**$2,389,221**	
7.0	**Other Costs**					
7.1	Project Management (5%)				$119,461	OSWER 9355.0-75
7.2	Engineering and Design (8%)				$191,138	OSWER 9355.0-75
7.3	Construction Management (6%)				$143,353	OSWER 9355.0-75
7.4	Location Adustment (10%)				$238,922	Means 2004 ER
7.5	Contingency (20%)				$477,844	OSWER 9355.0-75
	TOTAL OTHER COSTS				**$1,170,718**	
	TOTAL CAPITAL COSTS FOR ALTERNATIVE HBHA-5				**$3,559,939**	

Notes:
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE HBHA-5-OM
ALTERNATIVE HBHA-5 OPERATIONS AND MAINTENANCE COSTS
REMOVAL AND OFF-SITE DISPOSAL - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual O&M Costs						
OM.1.1	Periodic Inspections (Quarterly)	40	HR	$100.00	$4,000	[1]
	Subtotal				**$4,000**	
OM.2.0 Wetland Restoration Costs						
OM.2.1	Technician Labor	500	HR	$100.00	$50,000	[1]
OM.2.2	Supplemental Fill Material	60	CY	$30.00	$1,800	Means 2004 ER
OM.2.3	Planting Maintenance (10% of planting costs)	1	LS	$6,400.00	$6,400	[1]
OM.2.4	Annual Flora/Fauna Survey	1	LS	$15,000.00	$15,000	[1]
	Subtotal					
TOTAL ANNUAL O&M COSTS					**$73,200**	
OM.3.0 Other O&M Costs						
OM.3.1	Project Management (10%)				$7,320	OSWER 9355.0-75
OM.3.2	O&M Contingency (20%)				$14,640	OSWER 9355.0-75
TOTAL OTHER O&M COSTS					**$21,960**	
ANNUAL O&M COSTS ALTERNATIVE NS-4					**$95,160**	

Notes:

For Alternative HBHA-5, wetland maintenance was only assumed necessary for three years after construction.

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.

[1] Best estimate based on previous experience.

TABLE HBHA-5-PW
ALTERNATIVE HBHA-5 PRESENT WORTH ANALYSIS
REMOVAL AND OFF-SITE DISPOSAL - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$3,559,939	0	$0	$3,559,939	7.0%	1.000	$3,559,939
1	$0	$95,160	$0	$95,160	7.0%	0.935	$88,935
2	$0	$95,160	$0	$95,160	7.0%	0.873	$83,116
3	$0	$95,160	$0	$95,160	7.0%	0.816	$77,679
4	$0	$0	$0	$0	7.0%	0.763	$0
5	$0	$0	$0	$0	7.0%	0.713	$0
6	$0	$0	$0	$0	7.0%	0.666	$0
7	$0	$0	$0	$0	7.0%	0.623	$0
8	$0	$0	$0	$0	7.0%	0.582	$0
9	$0	$0	$0	$0	7.0%	0.544	$0
10	$0	$0	$0	$0	7.0%	0.508	$0
11	$0	$0	$0	$0	7.0%	0.475	$0
12	$0	$0	$0	$0	7.0%	0.444	$0
13	$0	$0	$0	$0	7.0%	0.415	$0
14	$0	$0	$0	$0	7.0%	0.388	$0
15	$0	$0	$0	$0	7.0%	0.362	$0
16	$0	$0	$0	$0	7.0%	0.339	$0
17	$0	$0	$0	$0	7.0%	0.317	$0
18	$0	$0	$0	$0	7.0%	0.296	$0
19	$0	$0	$0	$0	7.0%	0.277	$0
20	$0	$0	$0	$0	7.0%	0.258	$0
21	$0	$0	$0	$0	7.0%	0.242	$0
22	$0	$0	$0	$0	7.0%	0.226	$0
23	$0	$0	$0	$0	7.0%	0.211	$0
24	$0	$0	$0	$0	7.0%	0.197	$0
25	$0	$0	$0	$0	7.0%	0.184	$0
26	$0	$0	$0	$0	7.0%	0.172	$0
27	$0	$0	$0	$0	7.0%	0.161	$0
28	$0	$0	$0	$0	7.0%	0.150	$0
29	$0	$0	$0	$0	7.0%	0.141	$0
30	$0	$0	$0	$0	7.0%	0.131	$0
TOTAL	**$3,559,939**	**$285,480**	**$0**	**$3,845,419**			**$3,809,669**

TABLE HBHA-5-A
ALTERNATIVE HBHA-5 COST ASSUMPTIONS
REMOVAL AND OFF-SITE DISPOSAL - HBHA POND SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		RATIONALE
General Assumptions		
	Alternative HBHA-5 involved hydraulic dredging of sediments throughout the entire HBHA Pond and off-site disposal of sediments. Similar to HBHA-4, the alternative includes stabilization of the East Drainage Ditch and the Northern Shore of the Pond to prevent erosion of contaminated soil/sediment into the Pond.	
1.0 Mobilization/Demobilization		
One work week (5 days) assumed for mobilization of labor and equipment for this alternative.		
1.1	Equipment mobilization	Assume less than 50 mile haul distance for all equipment.
		Equipment would be mobilized and demobilized to and from the site once for this project.
		Unit costs include labor cost for equipment mob/demob.
1.2	Field Support Facilities	Field support facilities will be mobilized and demobilized to and from the central field support area once during the course of the project.
		The following items are included in this cost line item: office trailer @ $500, storage trailer @ $500, dumpster @ $100, sanitary facilities @ $100, soil sampling equipment @ $2000.
1.3	Monthly Costs associated with Field Support	Includes monthly rental costs for duration of project for the following: office trailer @ $400, storage trailer @ $200, utilities @ $200, dumpster @ $200, sampling materials @ $1000, air sampling equipment (PID) @ 750.
2.0 Site Preparation		
Site preparation assumptions are similar to those presented on Table NS-4-A for Alternative NS-4. Quantities have been adjusted accordingly to account for th differences in site conditions in the HBHA Pond area versus the remediation areas that are impacted by Alternative NS-4.		
3.0 Dredge HBHA Pond Sediments		
Under this alternative, sediments would be dredged from an area of the HBHA Pond encompassing approximately 190,000 SF. The assumed thickness of contaminated sediments in the Pond was 16 inches. 191,000 SF * 1.33 LF≈ 254,000 CF ≈ 9,400 CY in place.		
The cost estimates and remedial time frames that are presented in the cost estimate for hydraulic dredging in the HBHA Pond are based on discussions with a dredging contractor with experience performing dredging projects similar to those proposed for this alternative.		
4.0 Transportation and Off-Site Disposal Sediment		
The sediment that would be dredged from the HBHA Pond was assumed to contain approximately 20 percent solids. This estimate was based on observations made during sediment investigations in the Pond during the Remedial Investigation. For the purposes of estimating disposal quantities for the cost estimate, it was therefore assumed that 9,400 CY of sediment (in place), as estimated above, would translate to approximately 1,880 CY of solids that would require off-site disposal.		
For the purpose of estimating off-site disposal requirements, 1 CY of solids was assumed to weigh 1.5 tons, resulting in 2,820 tons of solids to be loaded into trucks and transported to the off-site landfill facility. Decontamination of heavy equipment would be performed for the duration of transportation and disposal activities to prevent the transport of contaminated material onto public or private roadways adjacent to the work site.		
The cost estimates for transportation and disposal of contaminated sediment are based on a quote from a disposal contractor, assuming that the sediment that is dredged from the Pond is characterized as hazardous based on the concentrations of arsenic present. Waste characterization samples would be collected from stockpiled sediments to verify this assumption. Costs for the collection and analysis of waste characterization samples are included in the disposal cost estimate.		
5.0 East Drainage Ditch Liner		
The assumptions and basis of cost for the stabilization of the East Drainage Ditch are presented on Table HBHA-4-A (Alternative HBHA-4). The work that would be conducted under this alternative would be identical to that which is included in Alternative HBHA-4.		
6.0 Permanent Erosion Control - Northern Shore of Pond		
The assumptions and basis of cost for permanent erosion control along the northern shore of the HBHA Pond are presented on Table HBHA-4-A (Alternative HBHA-4). The work that would be conducted under this alternative would be identical to that which is included in Alternative HBHA-4.		

TABLE NS-2
ALTERNATIVE NS-2 CAPITAL COSTS
INSTITUTIONAL CONTROLS - NEAR SHORE SEDIMENT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0 Institutional Controls						
1.1	Legal Fees, Deed Restrictions, Property Survey	1	EA	$20,000	$20,000	[1]
1.2	6-Foot Galvanized Chain-Link Fence	1,000	LF	$29.00	$29,000	Means HC 2004, 02820 130 0900
1.3	Access Gates	3	EA	$330.00	$990	Means HC 2004, 02820 130 1500
	Subtotal				**$49,990**	
TOTAL DIRECT COSTS					**$49,990**	
2.0 Other Costs						
2.1	Project Management (10%)				$4,999	OSWER 9355.0-75
2.2	Construction Management (15%)				$7,499	OSWER 9355.0-75
2.3	Contingency (15%)				$7,499	OSWER 9355.0-75
TOTAL OTHER COSTS					**$19,996**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE NS-2					**$69,986**	

Notes:
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE NS-2-OM
ALTERNATIVE NS-2 OPERATIONS AND MAINTENANCE COSTS
INSTITUTIONAL CONTROLS - NEAR SHORE SEDIMENT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual O&M Costs						
OM.1.1	Periodic Inspections (Quarterly)	40	HR	$100.00	$4,000	[1]
OM.1.2	Fence Repairs (Assume 20 LF/YR)	20	LF	$29.00	$580	Means HC, 02820 130 0900
OM.1.3	Reporting (Quarterly)	4	EA	$2,000.00	$8,000	[1]
	Subtotal				**$12,580**	
TOTAL ANNUAL O&M COSTS					**$12,580**	
OM.2.0 Other Costs						
OM.2.1	Project Management (10%)				$1,258	OSWER 9355.0-75
OM.2.2	O&M Contingency (20%)				$2,516	OSWER 9355.0-75
TOTAL OTHER O&M COSTS					**$3,774**	
ANNUAL O&M COSTS ALTERNATIVE NS-2					**$16,354**	

Notes:

Present worth analysis includes periodic cost of $30,000 for preparation of five-year review.

Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.

[1] Best estimate based on previous experience.

TABLE NS-2-PW
ALTERNATIVE NS-2 PRESENT WORTH ANALYSIS
INSTITUTIONAL CONTROLS - NEAR SHORE SEDIMENT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$69,986	0	$0	$69,986	7.0%	1.000	$69,986
1	$0	$16,354	$0	$16,354	7.0%	0.935	$15,284
2	$0	$16,354	$0	$16,354	7.0%	0.873	$14,284
3	$0	$16,354	$0	$16,354	7.0%	0.816	$13,350
4	$0	$16,354	$0	$16,354	7.0%	0.763	$12,476
5	$0	$16,354	$30,000	$46,354	7.0%	0.713	$33,050
6	$0	$16,354	$0	$16,354	7.0%	0.666	$10,897
7	$0	$16,354	$0	$16,354	7.0%	0.623	$10,184
8	$0	$16,354	$0	$16,354	7.0%	0.582	$9,518
9	$0	$16,354	$0	$16,354	7.0%	0.544	$8,895
10	$0	$16,354	$30,000	$46,354	7.0%	0.508	$23,564
11	$0	$16,354	$0	$16,354	7.0%	0.475	$7,770
12	$0	$16,354	$0	$16,354	7.0%	0.444	$7,261
13	$0	$16,354	$0	$16,354	7.0%	0.415	$6,786
14	$0	$16,354	$0	$16,354	7.0%	0.388	$6,342
15	$0	$16,354	$30,000	$46,354	7.0%	0.362	$16,801
16	$0	$16,354	$0	$16,354	7.0%	0.339	$5,540
17	$0	$16,354	$0	$16,354	7.0%	0.317	$5,177
18	$0	$16,354	$0	$16,354	7.0%	0.296	$4,839
19	$0	$16,354	$0	$16,354	7.0%	0.277	$4,522
20	$0	$16,354	$30,000	$46,354	7.0%	0.258	$11,979
21	$0	$16,354	$0	$16,354	7.0%	0.242	$3,950
22	$0	$16,354	$0	$16,354	7.0%	0.226	$3,691
23	$0	$16,354	$0	$16,354	7.0%	0.211	$3,450
24	$0	$16,354	$0	$16,354	7.0%	0.197	$3,224
25	$0	$16,354	$30,000	$46,354	7.0%	0.184	$8,541
26	$0	$16,354	$0	$16,354	7.0%	0.172	$2,816
27	$0	$16,354	$0	$16,354	7.0%	0.161	$2,632
28	$0	$16,354	$0	$16,354	7.0%	0.150	$2,460
29	$0	$16,354	$0	$16,354	7.0%	0.141	$2,299
30	$0	$16,354	$30,000	$46,354	7.0%	0.131	$6,089
TOTAL	**$69,986**	**$490,620**	**$180,000**	**$740,606**			**$337,658**

TABLE NS-2-A
ALTERNATIVE NS-2 COST ASSUMPTIONS
INSTITUTIONAL CONTROLS - NEAR SHORE SEDIMENT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
	CAPITAL COSTS (TABLE NS-2)	
General Assumptions		
	Alternative NS-2 involves the imposition of institutional controls on each of the properties that are located within the near-shore sediment contaminated areas that are depicted on Figures 2-5b and 2-5c of the FS. For the purposes of estimating cost for the FS, it was assumed that these areas were all located on one property. Institutional controls would include deed restrictions to control or prevent activities that might result in future exposures to sediment containing arsenic in excess of the human health PRGs that were developed for near-shore sediment (300 mg/kg in Reach 1 and 230 mg/kg in Reach 2N); and the construction of a fence at the perimeter of the areas where existing sediment could pose a future human health risk if the current exposure frequency were to be maintained in the future.	
1.0 Institutional Controls		
1.1	Legal Fees, Deed Restrictions, Property Surveys	Legal fees associated with drafting and implementing deed restrictions, costs to perform property surveys at $20,000 per property.
1.2	6-Foot Galvanized Chain-Link Fence	Aluminized steel chain-link fence, 6' high, installed.
		Crew B-80: 1 labor foreman, 1 laborer, 1 truck driver, 1 equipment operator, 1 flatbed truck, 1 fence post auger. Daily rate = $2000.
		1000 LF / 250 LF/day = 4 days.
1.3	Access Gates	3 access gates, 6' high, 3' wide. 1 day.
	OPERATIONS AND MAINTENANCE COSTS (TABLE NS-2-OM)	
OM.1.0 Annual O&M Costs		
OM.1.1	Periodic Inspections (Quarterly)	Assume 10 hours per quarter for inspections to verify the effectiveness of institutional controls at preventing exposure to sediment in Wells G&H wetland and Cranberry Bog Conservation Area.
OM.1.2	Fence Repairs	Assume 2% (20 LF) per year @ $29/LF.
OM.1.3	Inspection Reports (Quarterly)	Assume $2000 per quarter for the preparation of inspection reports to document quarterly inspection activities and findings.

TABLE NS-3
ALTERNATIVE NS-3 CAPITAL COSTS
MONITORING WITH INSTITUTIONAL CONTROLS - NEAR SHORE SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0 Institutional Controls						
1.1	Legal Fees, Deed Restrictions	1	LS	$20,000	$20,000	[1]
1.2	6-Foot Galvanized Chain-Link Fence	1,000	LF	$29.00	$29,000	Means HC 2004, 02820 0900
1.3	Access Gates	3	EA	$330.00	$990	Means HC 2004, 02820 1500
	Subtotal				**$49,990**	
TOTAL DIRECT COSTS					**$49,990**	
2.0 Other Costs						
2.1	Project Management (10%)				$4,999	OSWER 9355.0-75
2.2	Construction Management (15%)				$7,499	OSWER 9355.0-75
2.3	Contingency (15%)				$7,499	OSWER 9355.0-75
TOTAL OTHER COSTS					**$19,996**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE NS-3					**$69,986**	

Notes:
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE NS-3-OM
ALTERNATIVE NS-3 OPERATIONS AND MAINTENANCE COSTS
MONITORING WITH INSTITUTIONAL CONTROLS - NEAR SHORE SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual O&M Costs						
OM.1.1	Periodic Inspections (Quarterly)	40	HR	$100.00	$4,000	[1]
OM.1.2	Fence Repairs (Assume 20 LF/YR)	20	LF	$29.00	$580	Means HC, 02820 130 0900
OM.1.3	Sediment Sample Collection Labor (80 HR/quarter)	320	HR	$85.00	$27,200	[1]
OM.1.4	Sediment Sample Analysis (assume 20/quarter)					
1.4.1	*Metals (Arsenic)*	80	EA	$100.00	$8,000	[1]
1.4.2	*SVOCs*	80	EA	$250.00	$20,000	[1]
OM.1.5	Data Validation	80	HR	$100.00	$8,000	[1]
OM.1.6	Reporting	4	EA	$10,000.00	$40,000	[1]
TOTAL ANNUAL O&M COSTS					**$107,780**	
OM.2.0 Other O&M Costs						
OM.2.1	Project Management (10%)				$10,778	OSWER 9355.0-75
OM.2.2	O&M Contingency (15%)				$16,167	OSWER 9355.0-75
TOTAL OTHER O&M COSTS					**$26,945**	
ANNUAL O&M COSTS ALTERNATIVE NS-3					**$134,725**	

Notes:

Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.

Present worth analysis includes periodic cost of $30,000 for preparation of five-year review.

[1] Best estimate based on previous experience.

TABLE NS-3-PW
ALTERNATIVE NS-3 PRESENT WORTH ANALYSIS
MONITORING WITH INSTITUTIONAL CONTROLS - NEAR SHORE SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$69,986	0	$0	$69,986	7.00%	1.000	$69,986
1	$0	$134,725	$0	$134,725	7.00%	0.935	$125,911
2	$0	$134,725	$0	$134,725	7.00%	0.873	$117,674
3	$0	$134,725	$0	$134,725	7.00%	0.816	$109,976
4	$0	$134,725	$0	$134,725	7.00%	0.763	$102,781
5	$0	$134,725	$30,000	$164,725	7.00%	0.713	$117,447
6	$0	$134,725	$0	$134,725	7.00%	0.666	$89,773
7	$0	$134,725	$0	$134,725	7.00%	0.623	$83,900
8	$0	$134,725	$0	$134,725	7.00%	0.582	$78,411
9	$0	$134,725	$0	$134,725	7.00%	0.544	$73,281
10	$0	$134,725	$30,000	$164,725	7.00%	0.508	$83,738
11	$0	$134,725	$0	$134,725	7.00%	0.475	$64,007
12	$0	$134,725	$0	$134,725	7.00%	0.444	$59,820
13	$0	$134,725	$0	$134,725	7.00%	0.415	$55,906
14	$0	$134,725	$0	$134,725	7.00%	0.388	$52,249
15	$0	$134,725	$30,000	$164,725	7.00%	0.362	$59,704
16	$0	$134,725	$0	$134,725	7.00%	0.339	$45,636
17	$0	$134,725	$0	$134,725	7.00%	0.317	$42,650
18	$0	$134,725	$0	$134,725	7.00%	0.296	$39,860
19	$0	$134,725	$0	$134,725	7.00%	0.277	$37,253
20	$0	$134,725	$30,000	$164,725	7.00%	0.258	$42,568
21	$0	$134,725	$0	$134,725	7.00%	0.242	$32,538
22	$0	$134,725	$0	$134,725	7.00%	0.226	$30,409
23	$0	$134,725	$0	$134,725	7.00%	0.211	$28,420
24	$0	$134,725	$0	$134,725	7.00%	0.197	$26,561
25	$0	$134,725	$30,000	$164,725	7.00%	0.184	$30,350
26	$0	$134,725	$0	$134,725	7.00%	0.172	$23,199
27	$0	$134,725	$0	$134,725	7.00%	0.161	$21,681
28	$0	$134,725	$0	$134,725	7.00%	0.150	$20,263
29	$0	$134,725	$0	$134,725	7.00%	0.141	$18,937
30	$0	$134,725	$30,000	$164,725	7.00%	0.131	$21,639
TOTAL	**$69,986**	**$4,041,750**	**$180,000**	**$4,291,736**			**$1,806,529**

TABLE NS-3-A
ALTERNATIVE NS-3 COST ASSUMPTIONS
MONITORING WITH INSTITUTIONAL CONTROLS - NEAR SHORE SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
	CAPITAL COSTS (TABLE NS-3)	
General Assumptions		
	Alternative NS-3 is a limited action alternative that involves sediment monitoring to periodically evaluate sediment contaminant trends and human health risks associated with existing contaminant in near-shore sediment in the Wells G&H Wetland and Cranberry Bog Conservation Area. For the purpose of developing cost estimates for the FS, it was assumed that periodic sediment sampling events would include the collection of 20 samples within the contaminated areas delineated on Figures 2-5b and 2-5c. The present worth of this alternative was calculated by assuming quarterly sediment sampling events.	
	Alternative NS-3 also involves the imposition of institutional controls on each of the properties that are located within the near-shore sediment contaminated areas. Institutional controls that would be imposed under this alternative would be the same as those described on Table NS-2-A for Alternative NS-2.	
1.0 Institutional Controls		
1.1	Legal Fees, Deed Restrictions, Property Surveys	Legal fees associated with drafting and implementing deed restrictions, costs to perform property surveys at $20,000 per property.
1.2	6-Foot Galvanized Chain-Link Fence	Aluminized steel chain-link fence, 6' high, installed.
		Crew B-80: 1 labor foreman, 1 laborer, 1 truck driver, 1 equipment operator, 1 flatbed truck, 1 fence post auger. Daily rate = $2000.
		1000 LF / 250 LF/day = 4 days.
1.3	Access Gates	3 access gates, 6' high, 3' wide. 1 day.
	OPERATIONS AND MAINTENANCE COSTS (TABLE NS-3-OM)	
OM.1.0 Annual O&M Costs		
OM.1.1	Periodic Inspections (Quarterly)	Assume 10 hours per quarter for inspections to verify the effectiveness of institutional controls at preventing exposure to sediment in Wells G&H wetland and Cranberry Bog Conservation Area.
OM.1.2	Fence Repairs	Assume 2% (20 LF) per year @ $29/LF.
OM.1.3	Sediment Sample Collection Labor	Assume 2 samplers at 40 HR per sampling event = 80 HR/event.
OM.1.4	Sediment Sample Analysis	Assume 20 samples per event analyzed for metals and SVOCs
OM.1.5	Data Validation	Assume 20 HR/event for data validation (1 HR per sample) at $100/HR
OM.1.6	Inspection Reports (Quarterly)	Assume $10,000 per quarter for the preparation of inspection reports and data summary reports to document quarterly inspection/sampling activities and findings.

TABLE NS-4
ALTERNATIVE NS-4 CAPITAL COSTS
SEDIMENT REMOVAL AND OFF-SITE DISPOSAL - NEAR SHORE SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0	**Mobilization/Demobilization**					
1.1	Equipment Mobilization/Demobilization	1	LS	$20,000	$20,000	[1]
1.2	Field Support Facilities	1	LS	$3,200	$3,200	[1]
1.3	Monthly Costs associated with Field Support	4	MONTH	$3,000	$12,000	[1]
	Subtotal				**$35,200**	
2.0	**Site Preparation**					
2.1	Site Access Road Construction	850	SY	$6.65	$5,653	Means 2004 HC, 02720 200 0100
2.2	Clear and Grub	3	ACRE	$3,150	$9,450	Means 2004 HC, 02230 100 0020
2.3	Site Survey	1	LS	$5,000	$5,000	[1]
2.4	Construct Equipment Decontamination Pads	3	EA	$7,500	$22,500	Means 2004 HC
2.5	Construct Stockpiling Areas	3	EA	$2,500	$7,500	Means 2004 HC
2.6	Construct Dewatering Pads	6	EA	$2,500	$15,000	Means 2004 HC
2.7	Install Erosion and Sedimentation Controls	2,500	LF	$3.73	$9,325	Means 2004 HC, 02370 700 1250
2.8	Construct Coffer Dams (Wells G&H Wetland)	5,000	SF	$19.00	$95,000	Means 2004 HC, 02260 200 0020
	Subtotal				**$169,428**	
3.0	**Excavate, Stockpile, and Dewater Contaminated Sediments**					
3.1	Dewater Excavation Areas					
3.1.1	*Equipment Rental Costs*	1	LS	$3,600.00	$3,600	Rain for Rent, 2005
3.1.2	*Purchase Sand Filter Media (3 mil gallon capacity)*	1	LS	$7,800.00	$7,800	Rain for Rent, 2005
3.1.3	*System Installation Labor*	1	LS	$600.00	$600	Rain for Rent, 2005
3.1.4	*Operate and Attend Pumps*	20	DAY	$645.00	$12,900	Means 2004 HC, 02240 500 0900
3.2	Excavate Contaminated Sediment, Load into Trucks	2,500	CY	$7.32	$18,300	Means 2004 ER, 17 03 0276
3.3	Haul Waste to Dewatering Area, 12 CY Dump Trucks	2,875	CY	$3.39	$9,746	Means 2004 HC, 02315 490 0320
3.4	Dewater/Handle Sediment	2,875	CY	$1.32	$3,795	Means 2004 HC, 02230 500 0100
	Subtotal				**$56,741**	
4.0	**Transportation and Off-Site Disposal of Sediment**					
4.1	Waste Characterization Samples	6	EA	$500.00	$3,000	[1]
4.2	Load Solid Waste into Trucks	2,875	CY	$3.66	$10,523	Means 2004 ER, 17 03 0276
4.3	Transportation to Off-Site Hazardous Waste Landfill	4,313	TON	$90.00	$388,125	Means 2004 ER, 33 19 0205
4.4	Landfill Disposal Hazardous Bulk Solid Waste	4,313	TON	$240.00	$1,035,000	Means 2004 ER, 33 19 7264
4.5	Treat Dewatering Effluent (purchase add'l filter media)	1	LS	$1,300.00	$1,300	Rain for Rent, 2005
	Subtotal				**$1,437,948**	
5.0	**Wetland Restoration**					
5.1	Wetland Delineation and Flora/Fauna Survey	1	LS	$6,000.00	$6,000	[1]
5.2	Analyze/Test Fill and Topsoil (1 per 500 CY fill)	6	EA	$500.00	$2,875	[1]
5.3	Place Geotextile at Edges of Restoration Area	5,000	SF	$0.23	$1,144	Means 2004 HC, 02340 300 1510
5.4	Backfill Edges of Restoration Area with Stone (3/4-inch)	620	CY	$23.50	$14,570	Benevento, 2005
5.5	General Backfill (sand), Place w/ Minimal Compaction	1,275	CY	$10.76	$13,714	Means 2004 ER, 17 03 04326
5.6	Import, Place, and Grade Topsoil w/ Minimal Compaction	1,275	CY	$34.85	$44,416	Means 2004 HC, 02910 810 0500
5.7	Import and Install Coir Logs	100	EA	$500.00	$50,000	[1]
5.8	Import and Install Coir Fiber Mats	3,500	SY	$2.00	$7,000	[1]
5.9	Establish Ground Cover	32	MSF	$2,500.00	$80,000	[1]
5.10	Plantings	32	MSF	$2,000.00	$64,000	[1]
5.11	Mulching	32	MSF	$61.55	$1,970	Means 2004 HC, 02910 500 0250
	Subtotal				**$285,689**	
TOTAL DIRECT COSTS					**$1,985,005**	
6.0	**Other Costs**					
6.1	Project Management (6%)				$119,100	OSWER 9355.0-75
6.2	Engineering and Design (12%)				$238,201	OSWER 9355.0-75
6.3	Construction Management (8%)				$158,800	OSWER 9355.0-75
6.4	Location Adustment (10%)				$198,501	Means 2004 ER
6.5	Contingency (15%)				$297,751	OSWER 9355.0-75
TOTAL OTHER COSTS					**$1,012,353**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE NS-4					**$2,997,358**	

Notes:
Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE NS-4-OM
ALTERNATIVE NS-4 OPERATIONS AND MAINTENANCE COSTS
SEDIMENT REMOVAL AND OFF-SITE DISPOSAL - NEAR SHORE SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual O&M Costs						
OM.1.1	Periodic Inspections (Quarterly)	40	HR	$100.00	$4,000	[1]
	Subtotal				**$4,000**	
OM.2.0 Wetland Restoration Costs						
OM.2.1	Technician Labor	500	HR	$100.00	$50,000	[1]
OM.2.2	Supplemental Fill Material	60	CY	$30.00	$1,800	Means 2004 ER
OM.2.3	Planting Maintenance (10% of planting costs)	1	LS	$6,400.00	$6,400	[1]
OM.2.4	Annual Flora/Fauna Survey	1	LS	$15,000.00	$15,000	[1]
	Subtotal					
TOTAL ANNUAL O&M COSTS					**$73,200**	
OM.3.0 Other O&M Costs						
OM.3.1	Project Management (10%)				$7,320	OSWER 9355.0-75
OM.3.2	O&M Contingency (20%)				$14,640	OSWER 9355.0-75
TOTAL OTHER O&M COSTS					**$21,960**	
ANNUAL O&M COSTS ALTERNATIVE NS-4					**$95,160**	

Notes:

For Alternative NS-4, wetland maintenance was only assumed necessary for three years after construction.

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.

[1] Best estimate based on previous experience.

TABLE NS-4-PW
ALTERNATIVE NS-4 PRESENT WORTH ANALYSIS
SEDIMENT REMOVAL AND OFF-SITE DISPOSAL - NEAR SHORE SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$2,997,358	0	$0	$2,997,358	7.0%	1.000	$2,997,358
1	$0	$95,160	$0	$95,160	7.0%	0.935	$88,935
2	$0	$95,160	$0	$95,160	7.0%	0.873	$83,116
3	$0	$95,160	$0	$95,160	7.0%	0.816	$77,679
4	$0	$0	$0	$0	7.0%	0.763	$0
5	$0	$0	$0	$0	7.0%	0.713	$0
6	$0	$0	$0	$0	7.0%	0.666	$0
7	$0	$0	$0	$0	7.0%	0.623	$0
8	$0	$0	$0	$0	7.0%	0.582	$0
9	$0	$0	$0	$0	7.0%	0.544	$0
10	$0	$0	$0	$0	7.0%	0.508	$0
11	$0	$0	$0	$0	7.0%	0.475	$0
12	$0	$0	$0	$0	7.0%	0.444	$0
13	$0	$0	$0	$0	7.0%	0.415	$0
14	$0	$0	$0	$0	7.0%	0.388	$0
15	$0	$0	$0	$0	7.0%	0.362	$0
16	$0	$0	$0	$0	7.0%	0.339	$0
17	$0	$0	$0	$0	7.0%	0.317	$0
18	$0	$0	$0	$0	7.0%	0.296	$0
19	$0	$0	$0	$0	7.0%	0.277	$0
20	$0	$0	$0	$0	7.0%	0.258	$0
21	$0	$0	$0	$0	7.0%	0.242	$0
22	$0	$0	$0	$0	7.0%	0.226	$0
23	$0	$0	$0	$0	7.0%	0.211	$0
24	$0	$0	$0	$0	7.0%	0.197	$0
25	$0	$0	$0	$0	7.0%	0.184	$0
26	$0	$0	$0	$0	7.0%	0.172	$0
27	$0	$0	$0	$0	7.0%	0.161	$0
28	$0	$0	$0	$0	7.0%	0.150	$0
29	$0	$0	$0	$0	7.0%	0.141	$0
30	$0	$0	$0	$0	7.0%	0.131	$0
TOTAL	**$2,997,358**	**$285,480**	**$0**	**$3,282,838**			**$3,247,088**

TABLE NS-4-A
ALTERNATIVE NS-4 COST ASSUMPTIONS
SEDIMENT REMOVAL AND OFF-SITE DISPOSAL - NEAR SHORE SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	RATIONALE
	CAPITAL COSTS (TABLE NS-4)	
General Assumptions		
	Alternative NS-4 would involve the removal of sediment (to a depth of 1 foot below the sediment surface) in the portions of the Wells G&H Wetland and Cranberry Bog Conservation Area with sediment that exceeds human health based PRGs for arsenic. Sediment removal would be accomplished through the use of hydraulic excavators. Dewatering of stream channels would be performed in portions of the Wells G&H Wetland to facilitate sediment removal.	
	Excavated sediment would be transported to an on-site dewatering area where free liquids would be allowed to drain from sediment. Liquids would be collected in a sump area built into the dewatering pad, and pumped through a sand filter to remove arsenic prior to surface water discharge within the wetlan Dewatered sediment would then be transported to an EPA-approved off-site disposal facility.	
	Upon completion of sediment removal and confirmation that residual levels of arsenic in sediments do not exceed the PRG, 6" of clean sand would be imported to the site and placed into the excavated areas. This sand would be overlain by 6" of topsoil specified so that it would provide an adequate substrate for wetland restoration.	
1.0 Mobilization/Demobilization		
One work week (5 days) assumed for mobilization of labor and equipment for this alternative.		
1.1	Equipment mobilization	Assume less than 50 mile haul distance for all equipment.
		Equipment would be mobilized and demobilized to and from the site once for this project.
		Assume $200 for mob, $200 for demob per piece of equipment.
		Unit costs include labor cost for equipment mob/demob.
1.2	Field Support Facilities	Field support facilities will be mobilized and demobilized to and from the central field support area once during the course of the project.
		The following items are included in this cost line item: office trailer @ $500, storage trailer @ $500, dumpster @ $100, sanitary facilities @ $100, soil sampling equipment @ $2000.
1.3	Monthly Costs associated with Field Support	Includes monthly rental costs for duration of project for the following: office trailer @ $400, storage trailer @ $200, utilities @ $200, dumpster @ $200, sampling materials @ $1250, air sampling equipment (PID) @ 750.
		Estimated duration of project = 1 week (mobilization) + 1 week (site preparation) + 4 week (excavation) + 2 week (transportation/disposal) + 6 week (site restoration) = 14 weeks or approximately 4 months.
2.0 Site Preparation		
2.1	Site Access Road Construction	Approximately 500 LF of access road (15 FT width) assumed to be required to access excavation areas in Wells G&H Wetland and Cranberry Bog Conservation Area.
		500 LF * 15 LF = 7500 SF ≈ 850 SY.
		Temporary road using gravel fill, no surfacing, 6" gravel depth
		Crew B-36C: 1 labor foreman, 2 equipment operators, 1 truck driver, 1 dozer, 1 roller, 1 truck, 1 water tanker. Daily rate = $4,000.
		Production rate = 5000 SY/day.
2.2	Clear and Grub	Assume clear and grub of approximately 3 acres.
		Cut & chip light trees to 6" diameter.
		Crew B-7: 1 labor foreman, 4 laborers, 1 equipment operator.
		1 chipping machine, 1 front-end loader, 2 chainsaws
2.3	Site survey	Assume $5,000 for site survey to identify sampling locations/construction areas.
2.4	Construct Decontamination Pads	Decontamination pads would be constructed as described on Table SS-3-A for Alternative SS-3. For this alternative, three decontamination areas would be constructed - one on each side of the Wells G&H Wetland, and a third in the Cranberry Bog Conservation Area.
2.5	Construct Soil Stockpiling Area	Three stockpiling areas would be constructed for this alternative, one in each of the areas specified in Section 2.4.
2.6	Construct Dewatering Pads	Two dewatering pads would be constructed at each of the sediment handling areas described in Section 2.4, for a total of six dewatering areas. Dewatering areas would be similar in construction to stockpiling areas, and would provide a location for free liquids to drain out of excavated sediment and collect in a sump.
2.7	Install Erosion and Sedimentation Controls	Erosion and sedimentation controls would be installed at the perimeter of all work areas where erosion and sedimentation may impact sensitive environmental areas such as wetlands, surface water bodies, etc.
2.8	Construct Coffer Dams	In order to excavate sediment from the Wells G&H wetland, where much of the sediment is submerged beneath surface water, coffer dams would be constructed to divert the flow of water around the excavation area. Coffer dams would be constructed using temporary sheeting.
		Crew B-40: 1 pile driver foreman, 4 pile drivers, 2 equipment operators (crane), 1 equipment operator (oiler), 1 crane (40 ton), 1 vibratory hammer. Daily rate = $6,000.
		Production rate = 960 SF/day. 5,000 SF / 960 SF/day≈ 6 days.

TABLE NS-4-A
ALTERNATIVE NS-4 COST ASSUMPTIONS
SEDIMENT REMOVAL AND OFF-SITE DISPOSAL - NEAR SHORE SEDIMENTS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	RATIONALE
3.0 Excavate, Stockpile, and Dewater Contaminated Sediments		
Under this alternative, sediment would be excavated from the areas depicted on Figures 2-5b and 2-5c to a depth of 2 feet. Cost line items in this section include costs to dewater the Wells G&H wetland excavation areas, excavate sediment from the sediment contamination areas, transport sediment to the sediment dewatering areas, and handling sediment in the dewatering areas.		
3.1	Dewater Excavation Areas	Dewatering of excavation areas would be accomplished using a 3" pump capable of moving 50 gpm of water from the excavation area into two 18,000-gallon tanks. Water that is pumped into the first tank would be transferred into a second tank through a sand media filter that would use a biopolymer to remove arsenic from the water.
		A pilot test would be conducted to verify the effectiveness of the treatment method and water samples would be collected from the treated effluent prior to its discharge back into the wetland.
	Equipment rental costs	$3600 includes rental of pumps, hoses, tanks, sand filter unit, and mixer for biopolymer contact. Rental period assumed 28 days.
	Purchase sand filter medium	Medium for sand filter to treat approximately 250,000 gallons of water.
	System Installation Labor	$600 lump sum for system installation labor. Based on quote from Rain for Rent.
	Operate and Attend Pumps	Operate and attend pumps and system for 20 day excavation period. 1 equipment operator, 0.5 laborer. Daily rate = $645.
3.2	Excavate Contaminated Sediment, Load into	Excavate and Load, 1.0-CY Hydraulic Excavator, 20 CY/HR assumed to excavate sediment.
	Trucks	Crew CODET: 1 laborer, 1 hydraulic excavator, 2.00 CY bucket, 1 equipment operator. Daily rate = $1,400.
		2,500 CY * 1 HR/20 CY ≈ 125 HR. Assume 20 days for contingency.
3.3	Haul Waste to Dewatering Area	12 CY dump trucks, 0.5-mile round trip, 3.2 loads/hour. Assume two trucks transporting soil to prevent down time.
		Crew B-34B (2): 1 truck driver, 1 dump truck (16 ton). $850 daily rate.
		Assume bulking factor from removal of soil at 1.15. Therefore 2,500 CY sediment in-situ roughly equivalent to 2,875 CY of excavated sediment that will be hauled to dewatering areas.
3.4	Dewater/Handle Sediment	Sediment handling in dewatering area assumed to include moving sediment within dewatering area and transferring to second dewatering pad. Assume 200 HP dozer, FE loader.
		Crew B-10B: 2 equipment operators, 0.5 laborer, 1 dozer, 1 FE loader. Daily rate = $2000.
		Dewatering shall continue for duration of the project, therefore management of approximately 2,875 CY is expected.
4.0 Transportation and Off-Site Disposal of Sediment		
4.1	Waste Characterization Samples	Collect characterization samples from stockpiled material at a rate of 1 sample per 500 CY of sediment. Full waste characterization sampling would include TCLP, reactivity, corrosivity.
4.2	Load Solid Waste into Trucks	Excavate and Load, 1.0-CY Hydraulic Excavator, Medium Material, 40 CY/Hour Load waste from stockpiles into 20 CY dump trailers for transportation to disposal facility.
		Crew CODET: 1 laborer (semi-skilled), 1 hydraulic excavator, crawler, 2.00 CY Bucket, 1 equipment operator.
		2,875 CY * 1 HR/40 CY ≈ 72 HR ≈ 9 days.
4.3	Transportation to Off-Site Hazardous Waste Landfill	Assume transportation of stockpiled sediment using 20 CY dump trailers. 500-mile transportation distance to hazardous waste landfill assumed.
		1.5 tons per 1.0 cubic yards assumed for transportation and disposal estimates.
4.4	Off-Site Disposal of Soil	Assume disposal of waste at non-hazardous waste facility within 500 miles of site.
4.5	Treat Dewatering Effluent	Costs to treat dewatering effluent assume purchase of additional filter media and use of existing pump/tank system. $1,300 filter media would treat approx 250,000 gallons.
5.0 Wetland Restoration		
Due to the fact that excavation of sediment under this alternative would be conducted within wetland areas, backfilling and site restoration would involve the re-creation of wetland habitats. The costs developed for this cost item would be similar to those that were developed for Alternative SW-3, which involves wetland habitat restoration to compensate for lost resources in the HBHA Pond. The general assumptions that were made to develop these costs were used to develop cost for this alternative. The cost assumptions for Alternative SW-3 are provided on Table SW-3-A.		
The primary difference between construction of restored wetland areas in the Wells G&H Wetland/Cranberry Bog Conservation Area would be the placement of 3/4-inch crushed stone at the perimeter of the restored areas to act as a filter layer to sediment that may be transported toward the restored areas from adjacent areas. To provide a stable base for the placement of this stone layer, a durable geotextile would be placed on the sediment surface.		

TABLE DS-2
ALTERNATIVE DS-2 CAPITAL COSTS
MONITORING WITH INSTITUTIONAL CONTROLS - SEDIMENT CORE LOCATIONS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0 Institutional Controls						
1.1	Legal Fees, Deed Restrictions, Property Survey	2	LS	$20,000	$40,000	[1]
	Subtotal				**$40,000**	
TOTAL DIRECT COSTS					**$40,000**	
2.0 Other Costs						
2.1	Project Management (10%)				$4,000	OSWER 9355.0-75
TOTAL OTHER COSTS					**$4,000**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE DS-2					**$44,000**	

Notes:
[1] Best estimate based on previous experience.

TABLE DS-2-OM
ALTERNATIVE DS-2 OPERATIONS AND MAINTENANCE COSTS
MONITORING WITH INSTITUTIONAL CONTROLS - SEDIMENT CORE LOCATIONS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0 Annual O&M Costs						
OM.1.1	Periodic Inspections (Quarterly)	40	HR	$100.00	$4,000	[1]
OM.1.2	Inspection Reports (Quarterly)	4	EA	$5,000.00	$20,000	[1]
	Subtotal				**$24,000**	
TOTAL ANNUAL O&M COSTS					**$24,000**	
OM.2.0 Other Costs						
OM.2.1	Project Management (10%)				$2,400	OSWER 9355.0-75
OM.2.2	O&M Contingency (15%)				$3,600	OSWER 9355.0-75
TOTAL OTHER O&M COSTS					**$6,000**	
ANNUAL O&M COSTS ALTERNATIVE DS-2					**$30,000**	

Notes:
Present worth analysis includes periodic cost of $20,000 for preparation of five-year review.
[1] Best estimate based on previous experience.

TABLE DS-2-PW
ALTERNATIVE DS-2 PRESENT WORTH ANALYSIS
MONITORING WITH INSTITUTIONAL CONTROLS - SEDIMENT CORE LOCATIONS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$44,000	0	$0	$44,000	7.0%	1.000	$44,000
1	$0	$30,000	$0	$30,000	7.0%	0.935	$28,037
2	$0	$30,000	$0	$30,000	7.0%	0.873	$26,203
3	$0	$30,000	$0	$30,000	7.0%	0.816	$24,489
4	$0	$30,000	$0	$30,000	7.0%	0.763	$22,887
5	$0	$30,000	$20,000	$50,000	7.0%	0.713	$35,649
6	$0	$30,000	$0	$30,000	7.0%	0.666	$19,990
7	$0	$30,000	$0	$30,000	7.0%	0.623	$18,682
8	$0	$30,000	$0	$30,000	7.0%	0.582	$17,460
9	$0	$30,000	$0	$30,000	7.0%	0.544	$16,318
10	$0	$30,000	$20,000	$50,000	7.0%	0.508	$25,417
11	$0	$30,000	$0	$30,000	7.0%	0.475	$14,253
12	$0	$30,000	$0	$30,000	7.0%	0.444	$13,320
13	$0	$30,000	$0	$30,000	7.0%	0.415	$12,449
14	$0	$30,000	$0	$30,000	7.0%	0.388	$11,635
15	$0	$30,000	$20,000	$50,000	7.0%	0.362	$18,122
16	$0	$30,000	$0	$30,000	7.0%	0.339	$10,162
17	$0	$30,000	$0	$30,000	7.0%	0.317	$9,497
18	$0	$30,000	$0	$30,000	7.0%	0.296	$8,876
19	$0	$30,000	$0	$30,000	7.0%	0.277	$8,295
20	$0	$30,000	$20,000	$50,000	7.0%	0.258	$12,921
21	$0	$30,000	$0	$30,000	7.0%	0.242	$7,245
22	$0	$30,000	$0	$30,000	7.0%	0.226	$6,771
23	$0	$30,000	$0	$30,000	7.0%	0.211	$6,328
24	$0	$30,000	$0	$30,000	7.0%	0.197	$5,914
25	$0	$30,000	$20,000	$50,000	7.0%	0.184	$9,212
26	$0	$30,000	$0	$30,000	7.0%	0.172	$5,166
27	$0	$30,000	$0	$30,000	7.0%	0.161	$4,828
28	$0	$30,000	$0	$30,000	7.0%	0.150	$4,512
29	$0	$30,000	$0	$30,000	7.0%	0.141	$4,217
30	$0	$30,000	$20,000	$50,000	7.0%	0.131	$6,568
TOTAL	**$44,000**	**$900,000**	**$120,000**	**$1,064,000**			**$459,428**

TABLE DS-2-A
ALTERNATIVE DS-2 COST ASSUMPTIONS
MONITORING WITH INSTITUTIONAL CONTROLS - SEDIMENT CORE LOCATIONS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
	CAPITAL COSTS (TABLE DS-2)	
General Assumptions		
	Alternative DS-2 involves the imposition of institutional controls on each of the properties that are located within the contaminated sediment areas that are depicted on Figure 2-5d of the FS. For the purposes of estimating cost for the FS, it was assumed that two properties would be impacted by this alternative.	
1.0 Institutional Controls		
1.1	Legal Fees, Deed Restrictions, Property Surveys	Legal fees associated with drafting and implementing deed restrictions, costs to perform property surveys at $20,000 per property (two properties assumed).
	OPERATIONS AND MAINTENANCE COSTS (TABLE DS-2-OM)	
OM.1.0 Annual O&M Costs		
OM.1.1	Periodic Inspections (Quarterly)	Assume 10 hours per quarter for inspections to verify the effectiveness of institutional controls at preventing exposures to sediment in the sediment core areas (Figure 2-5d).
OM.1.2	Inspection Reports (Quarterly)	Assume $5000 per quarter for the preparation of inspection reports to document quarterly inspection activities and findings.

Notes:
Monitoring costs for Alternative DS-2 would be included in the selected surface water (SW) alternative.

TABLE DS-3
ALTERNATIVE DS-3 CAPITAL COSTS
SEDIMENT REMOVAL AND OFF-SITE DISPOSAL - SEDIMENT CORE LOCATIONS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0	**Mobilization/Demobilization**					
1.1	Equipment and Labor Mobilization/Demobilization	1	LS	$30,000	$30,000	[1]
1.2	Field Support Facilities	1	LS	$3,200	$3,200	[1]
1.3	Monthly Costs associated with Field Support	60	MONTH	$3,000	$180,000	excavate in one location at a time
	Subtotal				**$213,200**	
2.0	**Site Preparation**					
2.1	Site Access Road Construction	1,000	SY	$6.55	$6,550	Means 2004 HC, 02720 200 0300
2.2	Clear and Grub	4	ACRE	$3,150	$12,600	Means 2004 HC, 02230 100 0020
2.3	Site Survey	1	LS	$10,000	$10,000	[1]
2.4	Construct Equipment Decontamination Pads	2	EA	$7,500	$15,000	Means 2004 HC
2.5	Construct Stockpiling Areas	2	EA	$2,500	$5,000	Means 2004 HC
2.6	Construct Dewatering Pads	4	EA	$2,500	$10,000	Means 2004 HC
2.7	Install Erosion and Sedimentation Controls	2,500	LF	$3.73	$9,325	Means 2004 HC, 02370 700 1250
2.8	Sheet piling temporary cofferdam (drive, extract & salvage)	50,000	SF	$23.50	$1,175,000	Means 2004 HC, 02260 200 0060
2.9	Whalers and connections	50,000	SF	$33.50	$1,675,000	Means 2004 HC, 02260 200 0500
	Subtotal				**$2,918,475**	
3.0	**Excavate, Stockpile, and Dewater Contaminated Sediments**					
3.1	Dewater Excavation Areas					
3.1.1	*Equipment Rental Costs*	50	MONTH	$3,600.00	$180,000	Rain for Rent, 2005
3.1.2	*Purchase Sand Filter Media (30 mil gallon capacity)*	100	EA	$650.00	$65,000	Rain for Rent, 2005
3.1.3	*System Installation Labor*	1	LS	$600.00	$600	Rain for Rent, 2005
3.1.4	*Operate and Attend Pumps*	1,100	DAY	$645.00	$709,500	Means 2004 HC, 02240 500 0900
3.2	Excavate Contaminated Sediment (20 CY/HR)	160,000	CY	$7.32	$1,171,200	Means 2004 ER, 17 03 0276
3.3	Haul Waste to Dewatering Area, 12 CY Dump Trucks	184,000	CY	$3.39	$623,760	Means 2004 HC, 02315 490 0320
3.4	Dewater/Handle Sediment	184,000	CY	$1.32	$242,880	Means 2004 HC, 02230 500 0100
	Subtotal				**$2,992,940**	
4.0	**Transportation and Off-Site Disposal of Sediment**					
4.1	Waste Characterization Samples	368	EA	$500.00	$184,000	[1]
4.2	Load Solid Waste into Trucks	184,000	CY	$3.66	$673,440	Means 2004 ER, 17 03 0276
4.3	Transportation to Off-Site Hazardous Waste Landfill	202,400	TON	$90.00	$18,216,000	Means 2004 ER, 33 19 0205
4.4	Landfill Disposal Hazardous Bulk Solid Waste	202,400	TON	$240.00	$48,576,000	Means 2004 ER, 33 19 7264
4.5	Treat Dewatering Effluent (purchase add'l filter media)	120	EA	$1,300.00	$156,000	Rain for Rent, 2005
	Subtotal				**$67,805,440**	
5.0	**Wetland Restoration (33 acres)**					
5.1	Wetland Delineation and Flora/Fauna Survey	1	LS	$12,000.00	$12,000	[1]
5.2	Analyze/Test Fill and Topsoil (1 per 500 CY fill)	368	EA	$500.00	$184,000	[1]
5.3	General Backfill (sand), Place w/ Minimal Compaction	92,000	CY	$10.76	$989,920	Means 2004 ER, 17 03 04326
5.4	Import, Place, and Grade Topsoil w/ Minimal Compaction	92,000	CY	$34.85	$3,206,200	Means 2004 HC, 02910 810 0500
5.5	Import and Install Coir Logs	6,000	EA	$500.00	$3,000,000	[1]
5.6	Import and Install Coir Fiber Mats	160,000	SY	$2.00	$320,000	[1]
5.7	Establish Ground Cover	160	MSF	$2,500.00	$400,000	[1]
5.8	Plantings	160	MSF	$2,000.00	$320,000	[1]
5.9	Mulching	160	MSF	$61.55	$9,848	Means 2004 HC, 02910 500 0250
	Subtotal				**$8,441,968**	
TOTAL DIRECT COSTS					**$82,372,023**	

TABLE DS-3
ALTERNATIVE DS-3 CAPITAL COSTS
SEDIMENT REMOVAL AND OFF-SITE DISPOSAL - SEDIMENT CORE LOCATIONS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
6.0 Other Costs						
6.1	Project Management (5%)				$4,118,601	OSWER 9355.0-75
6.2	Engineering and Design (6%)				$4,942,321	OSWER 9355.0-75
6.3	Construction Management (6%)				$4,942,321	OSWER 9355.0-75
6.4	Location Adustment (10%)				$8,237,202	Means 2004 ER
6.5	Contingency (15%)				$12,355,803	OSWER 9355.0-75
TOTAL OTHER COSTS					**$34,596,250**	
TOTAL CAPITAL COSTS FOR ALTERNATIVE DS-3					**$116,968,273**	

Notes:

Means 2004 ER: R.S. Means Environmental Cost Data, 10th Annual Edition, 2004.

Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.

[1] Best estimate based on previous experience.

TABLE DS-3-PW
ALTERNATIVE DS-3 PRESENT WORTH ANALYSIS
SEDIMENT REMOVAL AND OFF-SITE DISPOSAL - SEDIMENT CORE LOCATIONS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$116,968,273	$0	$0	$116,968,273	7.0%	1.000	$116,968,273
1	$0	$100,000	$0	$100,000	7.0%	0.935	$93,458
2	$0	$100,000	$0	$100,000	7.0%	0.873	$87,344
3	$0	$100,000	$0	$100,000	7.0%	0.816	$81,630
4	$0	$100,000	$0	$100,000	7.0%	0.763	$76,290
5	$0	$100,000	$0	$100,000	7.0%	0.713	$71,299
6	$0	$0	$0	$0	7.0%	0.666	$0
7	$0	$0	$0	$0	7.0%	0.623	$0
8	$0	$0	$0	$0	7.0%	0.582	$0
9	$0	$0	$0	$0	7.0%	0.544	$0
10	$0	$0	$0	$0	7.0%	0.508	$0
11	$0	$0	$0	$0	7.0%	0.475	$0
12	$0	$0	$0	$0	7.0%	0.444	$0
13	$0	$0	$0	$0	7.0%	0.415	$0
14	$0	$0	$0	$0	7.0%	0.388	$0
15	$0	$0	$0	$0	7.0%	0.362	$0
16	$0	$0	$0	$0	7.0%	0.339	$0
17	$0	$0	$0	$0	7.0%	0.317	$0
18	$0	$0	$0	$0	7.0%	0.296	$0
19	$0	$0	$0	$0	7.0%	0.277	$0
20	$0	$0	$0	$0	7.0%	0.258	$0
21	$0	$0	$0	$0	7.0%	0.242	$0
22	$0	$0	$0	$0	7.0%	0.226	$0
23	$0	$0	$0	$0	7.0%	0.211	$0
24	$0	$0	$0	$0	7.0%	0.197	$0
25	$0	$0	$0	$0	7.0%	0.184	$0
26	$0	$0	$0	$0	7.0%	0.172	$0
27	$0	$0	$0	$0	7.0%	0.161	$0
28	$0	$0	$0	$0	7.0%	0.150	$0
29	$0	$0	$0	$0	7.0%	0.141	$0
30	$0	$0	$0	$0	7.0%	0.131	$0
TOTAL	**$116,968,273**	**$500,000**	**$0**	**$117,468,273**			**$117,378,292**

TABLE DS-3-A
ALTERNATIVE DS-3 COST ASSUMPTIONS
SEDIMENT REMOVAL AND OFF-SITE DISPOSAL - SEDIMENT CORE LOCATIONS
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		RATIONALE
CAPITAL COSTS (TABLE DS-3)		
General Assumptions		
	Alternative DS-3 would involve the removal of sediment in the portions of the Halls Brook Holding Area (to a depth of 2 feet below the sediment surface) and in the portions of the Wells G&H Wetland (to an average depth of 3 feet below the sediment surface) where sediment contains concentrations of arsenic that exceed the human-health based PRGs for arsenic (dredger scenario). Sediment removal would be accomplished through the use of hydraulic excavators. Dewatering of stream channels would be performed in portions of the excavation areas to facilitate sediment removal.	
	The assumptions that were used to develop costs for this alternative are similar to those described for Alternative NS-4. More description of these assumptions is provided on Table NS-4-A.	
1.0 Mobilization/Demobilization		
One work week (5 days) assumed for mobilization of labor and equipment for this alternative.		
1.1	Equipment mobilization	Assume less than 50 mile haul distance for all equipment.
		Equipment would be mobilized and demobilized to and from the site once for this project.
		Assume $200 for mob, $200 for demob per piece of equipment.
		Unit costs include labor cost for equipment mob/demob.
1.2	Field Support Facilities	Field support facilities will be mobilized and demobilized to and from the central field support area once during the course of the project.
		The following items are included in this cost line item: office trailer @ $500, storage trailer @ $500, dumpster @ $100, sanitary facilities @ $100, soil sampling equipment @ $2000.
1.3	Monthly Costs associated with Field Support	Includes monthly rental costs for duration of project for the following: office trailer @ $400, storage trailer @ $200, utilities @ $200, dumpster @ $200, sampling materials @ $1250, air sampling equipment (PID) @ 750.
		Project duration assumed approximately 60 months based on sediment excavation rate of 20 CY/HR and time required to restore excavated areas with wetland species.
2.0 Site Preparation		
The assumptions that were used to develop costs for site preparation for Alternative DS-3 are similar to those provided under Section 2.0 of Table NS-4-A. The major difference is the size and scope of the dewatering effort that would be required to complete this alternative. The quantities of sheet piling have been adjusted upwards to reflect the quantity needed to dewater the excavation areas that would be targeted under this alternative.		
3.0 Excavate, Stockpile, and Dewater Contaminated Sediments		
Excavation, stockpiling, and dewatering of contaminated sediment would be as described for Alternative NS-4 (Table NS-4-A), scaled upwards to reflect the level of effort that would be required to remove the volume of sediment that is targeted under this alternative. The estimated duration of excavation activities for this alternative would be		
4.0 Transportation and Off-Site Disposal of Sediment		
Transportation and off-site disposal of sediment would be conducted as described for Alternative NS-4 (Table NS-4-A).		
5.0 Wetland Restoration		
Due to the fact that excavation of sediment under this alternative would be conducted within wetland areas, backfilling and site restoration would involve the re-creation of wetland habitats. The costs developed for this cost item would be similar to those that were developed for Alternative SW-3, which involves wetland habitat restoration to compensate for lost resources in the HBHA Pond. The general assumptions that were made to develop these costs were used to develop cost for this alternative. The cost assumptions for Alternative SW-3 are provided on Table SW-3-A. The estimated area of wetlands that would need to be restored under this alternative would be 33 acres.		

TABLE SW-2-OM
ALTERNATIVE SW-2 OPERATION AND MAINTENANCE COSTS
SURFACE WATER MONITORING
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0	**Base Flow Surface Water Monitoring Costs (per year)**					
OM.1.1	Sample Collection Labor (10 locations/quarter)	200	HR	$100	$20,000	[1]
OM.1.2	Sampling Equipment Rental	4	EA	$1,000	$4,000	[1]
OM.1.3	Sampling Supplies	4	LS	$2,000	$8,000	[1]
OM.1.4	Surface Water Sample Analyses (12 samples/quarter)					
1.4.1	*Metals (Arsenic)*	48	EA	$125	$6,000	[1]
1.4.2	*VOCs*	48	EA	$250	$12,000	[1]
1.4.3	*Suspended Solids*	48	EA	$50	$2,400	[1]
OM.1.5	Data Validation	80	HR	$100	$8,000	[1]
OM.1.6	Reporting	100	HR	$100	$10,000	[1]
	Subtotal				**$70,400**	
OM.2.0	**Storm Event Surface Water Sampling (per year)**					
OM.2.1	Sample Collection Labor (10 locations/event)	800	HR	$100	$80,000	[1]
OM.2.2	Sampling Equipment Rental	2	EA	$5,000	$10,000	[1]
OM.2.3	Surface Water Sample Analyses (12 samples/event)					
2.3.1	*Metals (Arsenic)*	24	EA	$125	$3,000	[1]
2.3.2	*VOCs*	24	EA	$250	$6,000	[1]
2.3.3	*Suspended Solids*	24	EA	$50	$1,200	[1]
OM.2.4	Data Validation	80	HR	$100	$8,000	[1]
OM.2.5	Reporting	100	HR	$100	$10,000	[1]
	Subtotal				**$118,200**	
TOTAL ANNUAL O&M COSTS					**$188,600**	
OM.3.0	**Other Costs**					
OM.3.1	Project Management (10%)				$18,860	OSWER 9355.0-75
OM.3.2	O&M Contingency (15%)				$28,290	OSWER 9355.0-75
TOTAL OTHER O&M COSTS					**$47,150**	
ANNUAL O&M COSTS ALTERNATIVE SW-2					**$235,750**	

Note:

There are no capital costs associate with Alternative SW-2.

[1] Best estimate based on previous experience.

TABLE SW-2-PW
ALTERNATIVE SW-2 PRESENT WORTH ANALYSIS
SURFACE WATER MONITORING
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$0	$235,750	$0	$235,750	7.0%	1.000	$235,750
1	$0	$235,750	$0	$235,750	7.0%	0.935	$220,327
2	$0	$235,750	$0	$235,750	7.0%	0.873	$205,913
3	$0	$235,750	$0	$235,750	7.0%	0.816	$192,442
4	$0	$235,750	$0	$235,750	7.0%	0.763	$179,853
5	$0	$235,750	$30,000	$265,750	7.0%	0.713	$189,476
6	$0	$235,750	$0	$235,750	7.0%	0.666	$157,090
7	$0	$235,750	$0	$235,750	7.0%	0.623	$146,813
8	$0	$235,750	$0	$235,750	7.0%	0.582	$137,209
9	$0	$235,750	$0	$235,750	7.0%	0.544	$128,232
10	$0	$235,750	$30,000	$265,750	7.0%	0.508	$135,094
11	$0	$235,750	$0	$235,750	7.0%	0.475	$112,003
12	$0	$235,750	$0	$235,750	7.0%	0.444	$104,676
13	$0	$235,750	$0	$235,750	7.0%	0.415	$97,828
14	$0	$235,750	$0	$235,750	7.0%	0.388	$91,428
15	$0	$235,750	$30,000	$265,750	7.0%	0.362	$96,320
16	$0	$235,750	$0	$235,750	7.0%	0.339	$79,857
17	$0	$235,750	$0	$235,750	7.0%	0.317	$74,632
18	$0	$235,750	$0	$235,750	7.0%	0.296	$69,750
19	$0	$235,750	$0	$235,750	7.0%	0.277	$65,187
20	$0	$235,750	$30,000	$265,750	7.0%	0.258	$68,675
21	$0	$235,750	$0	$235,750	7.0%	0.242	$56,937
22	$0	$235,750	$0	$235,750	7.0%	0.226	$53,212
23	$0	$235,750	$0	$235,750	7.0%	0.211	$49,731
24	$0	$235,750	$0	$235,750	7.0%	0.197	$46,477
25	$0	$235,750	$30,000	$265,750	7.0%	0.184	$48,964
26	$0	$235,750	$0	$235,750	7.0%	0.172	$40,595
27	$0	$235,750	$0	$235,750	7.0%	0.161	$37,939
28	$0	$235,750	$0	$235,750	7.0%	0.150	$35,457
29	$0	$235,750	$0	$235,750	7.0%	0.141	$33,138
30	$0	$235,750	$30,000	$265,750	7.0%	0.131	$34,911
TOTAL	**$0**	**$7,308,250**	**$180,000**	**$7,488,250**			**$3,225,916**

TABLE SW-2-A
ALTERNATIVE SW-2 COST ASSUMPTIONS
SURFACE WATER MONITORING
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
	CAPITAL COSTS	
General Assumptions		
	There are no capital costs associated with Alternative SW-2 since no actions would be taken to contain or treat surface water. Alternative SW-2 would involve the implementation of a surface water monitoring program to measure the concentration of dissolved and particulate arsenic, VOCs, and suspended solids in surface water at several locations along the Halls Brook Holding Area and Aberjona River. The surface water monitoring program would be similar to the program that was implemented as part of the MSGRP Remedial Investigation.	
	OPERATIONS AND MAINTENANCE COSTS (TABLE SW-2-OM)	
OM.1.0 Base Flow Surface Water Monitoring Costs		
	The surface water monitoring program that would be implemented under Alternative SW-2 would involve the collection of base flow surface water samples from 10 stations along the Aberjona River. One surface water sample would be collected from each sampling station per quarter during base flow conditions and analyzed for the presence of metals, VOCs, and suspended solids.	
OM.1.1	Sample Collection Labor	Assume 50 HR per quarter to collect base flow surface water samples (10 samples), process samples and paperwork, and package/ship samples to laboratory.
OM.1.2	Sampling Equipment Rental	Sampling equipment includes weekly rental or purchase of the following items: pickup truck/van, sampling tools, surface water samplers, and decontamination equipment/supplies.
OM.1.3	Sampling Supplies	Sampling supplies include purchase of consumable items such as sample containers, packing/shipping materials, etc.
OM.1.4	Surface Water Sample Analyses	12 samples per event (including QC) analyzed for arsenic, VOCs, and suspended solids
OM.1.5	Data Validation	20 HR per event for data validation = 80 HR per year.
OM.1.6	Reporting	25 HR per event for reporting of data = 100 HR per year.
OM.2.0 Storm Event Surface Water Sampling		
	Surface water samples would be collected twice per year from each of the ten stations during a storm event to monitor the transport of particulate arsenic and suspended solids during storm events.	
OM.2.1	Sample Collection Labor	400 HR per event to set up sampling stations, collect and ship samples.
OM.2.2	Sampling Equipment Rental	Sampling equipment includes weekly rental or purchase of the following items: pickup truck/van, sampling tools, surface water samplers, and decontamination equipment/supplies.
OM.2.3	Surface Water Sample Analyses	12 samples per event (including QC) analyzed for arsenic, VOCs, and suspended solids
OM.2.4	Data Validation	20 HR per event for data validation = 80 HR per year.
OM.2.5	Reporting	25 HR per event for reporting of data = 100 HR per year.

TABLE SW-3
ALTERNATIVE SW-3 CAPITAL COSTS
SURFACE WATER MONITORING AND PROVIDE ALTERNATE HABITAT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
1.0	**Alternate Habitat (per acre)**					
1.1	Property Acquisition	1	ACRE	$700,000.00	$700,000	[1]
1.2	Site Prep, Equipment Mob/Demob, Layout	1	LS	$15,000.00	$15,000	[1]
1.3	Excavate Wetland (estimate 4 foot average)	6,500	CY	$1.68	$10,920	Means 2004 HC, 02300 424 0260
1.4	Haul to Stockpile Area	8,125	CY	$2.94	$23,888	Means 2004 HC, 02315 490 0310
1.5	Load for Off-Site Disposal	8,125	CY	$1.35	$10,969	Means 2004 HC, 02300 424 1300
1.6	Stockpile Management	1	LS	$5,000.00	$5,000	[1]
1.7	Analyze/Test Fill and Topsoil (1 per 500 CY fill)	4	EA	$500.00	$2,000	[1]
1.8	Import, Place, and Grade Topsoil w/ Minimal Compaction	1,600	CY	$34.85	$55,760	Means 2004 HC, 02910 810 0500
1.9	Import and Install Coir Logs	100	EA	$500.00	$50,000	[1]
1.10	Import and Install Coir Fiber Mats	5,000	SY	$2.00	$10,000	[1]
1.11	Establish Ground Cover	44	MSF	$2,500.00	$110,000	[1]
1.12	Plantings	44	MSF	$2,000.00	$88,000	[1]
1.13	Mulching	44	MSF	$61.55	$2,708	Means 2004 HC, 02910 500 0250
	Subtotal				**$1,084,244**	
2.0	**Alternate Habitat (Based on Section 2.0)**					
2.1	Four Additional 1-Acre Wetlands to Provide 5 Acres Total	4	EA	$1,084,244	$4,336,978	See Section 2.0 above
	Subtotal				**$4,336,978**	
TOTAL DIRECT COSTS					**$5,421,222**	
3.0	**Other Costs**					
3.1	Project Management (5%)				$271,061	OSWER 9355.0-75
3.2	Engineering and Design (8%)				$433,698	OSWER 9355.0-75
3.3	Construction Management (6%)				$325,273	OSWER 9355.0-75
3.4	Location Adjustment (10%)				$542,122	Means 2004 ER
3.5	Contingency (15%)				$813,183	OSWER 9355.0-75
TOTAL OTHER COSTS					**$2,385,338**	
TOTAL COST FOR REMEDIAL ALTERNATIVE SW-3					**$7,806,560**	

NOTES:
Means 2004 HC: R.S. Means Heavy Construction Cost Data, 18th Annual Edition, 2004.
[1] Best estimate based on previous experience.

TABLE SW-3-OM
ALTERNATIVE SW-3 OPERATIONS AND MAINTENANCE COSTS
SURFACE WATER MONITORING AND PROVIDE ALTERNATE HABITAT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	SOURCE/NOTE
OM.1.0	**Base Flow Surface Water Monitoring Costs (per year)**					
OM.1.1	Sample Collection Labor (10 samples/quarter)	200	HR	$100	$20,000	[1]
OM.1.2	Sampling Equipment Rental	4	EA	$1,000	$4,000	[1]
OM.1.3	Sampling Supplies	4	LS	$2,000	$8,000	[1]
OM.1.4	Surface Water Sample Analyses (12 samples/quarter)					
1.4.1	*Metals (Arsenic)*	48	EA	$125	$6,000	[1]
1.4.2	*VOCs*	48	EA	$250	$12,000	[1]
1.4.3	*Suspended Solids*	48	EA	$50	$2,400	[1]
OM.1.5	Data Validation	80	HR	$100	$8,000	[1]
OM.1.6	Reporting	100	HR	$100	$10,000	[1]
	Subtotal				**$70,400**	
OM.2.0	**Storm Event Surface Water Sampling (per year)**					
OM.2.1	Sample Collection Labor (10 samples/quarter)	800	HR	$100	$80,000	[1]
OM.2.2	Sampling Equipment Rental	2	EA	$5,000	$10,000	[1]
OM.2.3	Surface Water Sample Analyses (12 samples/event)					
2.3.1	*Metals (Arsenic)*	24	EA	$125	$3,000	[1]
2.3.2	*VOCs*	24	EA	$250	$6,000	[1]
2.3.3	*Suspended Solids*	24	EA	$50	$1,200	[1]
OM.2.4	Data Validation	80	HR	$100	$8,000	[1]
OM.2.5	Reporting	100	HR	$100	$10,000	[1]
	Subtotal				**$118,200**	
TOTAL ANNUAL O&M COSTS					**$188,600**	
OM.3.0	**Other Costs**					
OM.3.1	Project Management (10%)				$18,860	OSWER 9355.0-75
OM.3.2	O&M Contingency (15%)				$28,290	OSWER 9355.0-75
TOTAL OTHER O&M COSTS					**$47,150**	
ANNUAL O&M COSTS ALTERNATIVE SW-3					**$235,750**	

Note:
[1] Best estimate based on previous experience.

TABLE SW-3-PW
ALTERNATIVE SW-3 PRESENT WORTH ANALYSIS
SURFACE WATER MONITORING AND PROVIDE ALTERNATE HABITAT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

Year	Capital	O&M	Periodic	Total	Discount	Factor	Present Value
0	$7,806,560	$0	$0	$7,806,560	7.0%	1.000	$7,806,560
1	$0	$235,750	$0	$235,750	7.0%	0.935	$220,327
2	$0	$235,750	$0	$235,750	7.0%	0.873	$205,913
3	$0	$235,750	$0	$235,750	7.0%	0.816	$192,442
4	$0	$235,750	$0	$235,750	7.0%	0.763	$179,853
5	$0	$235,750	$30,000	$265,750	7.0%	0.713	$189,476
6	$0	$235,750	$0	$235,750	7.0%	0.666	$157,090
7	$0	$235,750	$0	$235,750	7.0%	0.623	$146,813
8	$0	$235,750	$0	$235,750	7.0%	0.582	$137,209
9	$0	$235,750	$0	$235,750	7.0%	0.544	$128,232
10	$0	$235,750	$30,000	$265,750	7.0%	0.508	$135,094
11	$0	$235,750	$0	$235,750	7.0%	0.475	$112,003
12	$0	$235,750	$0	$235,750	7.0%	0.444	$104,676
13	$0	$235,750	$0	$235,750	7.0%	0.415	$97,828
14	$0	$235,750	$0	$235,750	7.0%	0.388	$91,428
15	$0	$235,750	$30,000	$265,750	7.0%	0.362	$96,320
16	$0	$235,750	$0	$235,750	7.0%	0.339	$79,857
17	$0	$235,750	$0	$235,750	7.0%	0.317	$74,632
18	$0	$235,750	$0	$235,750	7.0%	0.296	$69,750
19	$0	$235,750	$0	$235,750	7.0%	0.277	$65,187
20	$0	$235,750	$30,000	$265,750	7.0%	0.258	$68,675
21	$0	$235,750	$0	$235,750	7.0%	0.242	$56,937
22	$0	$235,750	$0	$235,750	7.0%	0.226	$53,212
23	$0	$235,750	$0	$235,750	7.0%	0.211	$49,731
24	$0	$235,750	$0	$235,750	7.0%	0.197	$46,477
25	$0	$235,750	$30,000	$265,750	7.0%	0.184	$48,964
26	$0	$235,750	$0	$235,750	7.0%	0.172	$40,595
27	$0	$235,750	$0	$235,750	7.0%	0.161	$37,939
28	$0	$235,750	$0	$235,750	7.0%	0.150	$35,457
29	$0	$235,750	$0	$235,750	7.0%	0.141	$33,138
30	$0	$235,750	$30,000	$265,750	7.0%	0.131	$34,911
TOTAL	**$7,806,560**	**$7,072,500**	**$180,000**	**$15,059,060**			**$10,796,726**

TABLE SW-3-A
ALTERNATIVE SW-3 COST ASSUMPTIONS
SURFACE WATER MONITORING AND PROVIDE ALTERNATE HABITAT
INDUSTRI-PLEX MSGRP FEASIBILITY STUDY
WOBURN, MASSACHUSETTS

	DESCRIPTION	COST ESTIMATE BASIS
	CAPITAL COSTS (TABLE SW-3)	
General Assumptions		
	Capital costs for Alternative SW-3 would involve the purchase of land (5 acres) and construction of wetlands on this land as compensation for the lost ecological habitat in the HBHA Pond. For the purpose of estimating costs for the FS, it was assumed that purchase of one parcel of land that is 5 acres in size would not be feasible given the limited availability of undeveloped land in the watershed and the cost of property in the area. Therefore, in Section 1.0 below the cost for 1 acre of created wetland is estimated, and in Section 2.0 this cost is multiplied by four to estimate the cost to purchase land and construct wetlands on five separate one-acre parcels.	
1.0 Provide Alternate Habitat		
1.1	Property Acquisition	Price per acre based on selling price of commercial property in the vicinity of site.
1.2	Site Prep, Equipment Mob/Demob, Layout	Site preparation includes construction of access roads/haul roads where necessary, clearing and grubbing, installing erosion and sedimentation controls at perimeter of work area, and all other activities required to prepare site for excavation and wetland construction.
1.3	Excavate Wetland	Assumes excavation of approximately 4 feet of soil to create wetland habitat.
		1 acre = 43,560 SF. 43,560 SF * 4 LF = 174,240 CF ≈ 6,500 CY.
1.4	Haul to Stockpile Area	Excavated soil hauled to a stockpile area within 1/4-mile of excavation site.
		Assume bulking factor of 1.25 for excavated soil.
1.5	Load for Off-Site Disposal	Load soil into trucks for off-site transport. Clean material assumed for reuse at off-site location.
1.6	Stockpile Management	Mangement of stockpiled soil with dozer, FE loader.
1.7	Analyze/Test Fill and Topsoil	One sample collected from each 500 CY of fill and topsoil material to verify no contaminants present. Samples analyzed for VOCs, SVOCs, and metals.
1.8	Import, Place, and Grade Topsoil	Topsoil imported and placed into wetland with minimal compaction
		One-foot of topsoil to cover wetland. 43,560 SF * 1 LF = 43,560 CF ≈ 1,600 CY.
1.9	Import and Install Coir Logs	Coir logs placed at perimeter of wetland area at the mean annual water level to stabilize edges of wetland and provide planting substrate for wetland vegetation.
		Assume 1 acre parcel roughly square with ≈ 200 LF sides. 800 LF coir logs / 10 LF/log ≈ 80 logs. Assume 100 logs to provide safety factor.
1.10	Import and Install Coir Fiber Mats	Coir fiber mats would be placed at the base of the wetland area to provide soil stabilization throughout the new wetland area until vegetation is established. Coir mats will also hold water so that the underlying soil does not dry out.
		1 acre = 43,560 SF ≈ 9,000 SY.
2.0 Alternate Habitat (Based on Section 2.0)		
2.1	Four Additional 1-Acre Wetlands to Provide 5 Acres Total	Subtotal from Section 1.0 multiplied by four to estimate construction of five acres of wetland on five separate parcels of land.
	OPERATIONS AND MAINTENANCE COSTS (TABLE SW-3-OM)	
OM.1.0 Base Flow Surface Water Monitoring Costs		
	The surface water monitoring program that would be implemented under Alternative SW-3 would be the same as described for Alternative SW-2. The assumptions that were used to develop costs for this monitoring program are provided on Table SW-2-OM.	
OM.2.0 Storm Event Surface Water Sampling		
	As described on Table SW-2-OM, surface water samples would be collected twice per year from each of the ten stations during a storm event to monitor the transport of particulate arsenic and suspended solids during storm events. The assumptions that were used to develop these costs are provided on Table SW-2-OM.	